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TRACK ELEVATION IN CHICAGO is progressing in a gratifying manner. During 1898, according to the recent report of Mr. John O'Neil, Superintendent of Track Elevation, 16.2 miles of track were elevated and 96 grade crossings were removed. The ordinances of that year also provided for 14.3 miles more to be elevated and the removal of 88 additional grade crossings, and work will be continued on these during the present year. The accompanying table, from the official report of Mr. O'Neil, shows the mileage of track of various kinds elevated and depressed from Jan. 1, 1892, to Dec. 31, 1898, inclusive:

Tracks Elevated.

Railroad.	Track laid—Main.	Yard.	Other.	Total.
Chicago & Alton.....	0.61	.....	....	0.61
C. & N. Westn: Mil. Div.	11.25	0.40	0.40	12.05
Galena Division.	12.71	4.23	0.35	17.29
Wisconsin Division ..	13.53	2.28	0.25	16.06
Rockwell St. Division.	5.64	....	0.76	*6.85
C.,M. & St.P.: Chic. Div.	6.32	1.14	....	7.46
C. & C. B Division..	2.53	....	0.30	2.83
Chic., R. I. & Pacific...	20.86	14.08	1.08	36.02
C. T. T.	1.74	....	0.24	1.98
Ill. Central: Main line..	20.24	....	....	20.24
St. Charles Air Line..	3.36	....	0.23	3.59
C., M. & N.....	0.61	....	....	0.61
Lake Shore & M. S.....	20.48	25.88	3.00	49.36
Pitts.,Cin., Chic. & St. L.	4.29	....	1.08	5.37
Pitts., Ft. Wayne & Chic.	10.00	9.00	1.16	20.16
Total	134.17	57.01	8.85	200.48

Tracks Depressed.

Atch., Top. & Santa Fe.	1.06	1.12	....	2.18
Chic. & Western Ind.....	2.28	2.01	0.96	5.25
Illinois Central	50.24	....	....	50.24
Total	53.58	3.13	0.96	57.67

*This includes 0.45-mile of side track.

THE PENNSYLVANIA RAILROAD REPORT FOR 1898 shows 84,801,805 tons carried on lines east of Pittsburg and Erie, a gain of 5,239,340 tons on last year's business; the lines west of these points carried 59,478,775 tons, a gain of over 7,600,000 tons. But the average rate per ton-mile fell to 0.499 ct., as compared with 0.536 ct. in 1897, and 0.564 ct. in 1896. Besides increasing tonnage the company materially reduced the cost of transportation by the use of heavier power and cars of greater capacity, improving track facilities, etc. The average expense per ton-mile was thus reduced to 0.355 ct. The Eastern lines show gross earnings of $65,603,737, with $21,093,722 net returns, deducting funded debt and rentals $9,108,089 were paid in a 5% dividend on the $129,305,000 of capital stock, and a balance was left of $2,642,852. Out of this balance $1,800,000 was set aside to complete extraordinary improvements. The Eastern and Western lines together show gross earnings of $132,869,470, an increase of $4,591,383, and net earnings of $39,960,140. This latter is a decrease of $676,914 over 1897, but the Western lines show for the year a net gain of $1,880,744, though there were relatively heavier outlays for putting these lines in condition to move freight economically at the prevailing low rates.

AN ALPINE RAILWAY to compete with the St. Gothard line for travel between Germany and Italy is being discussed. This is the Bintschgau Railway, connecting Landeck and Meran, which may be built by Austria. The longest tunnel, that between Trafoi and the Zebru Valley, would be but 4.65 miles long, as compared with the nine miles of the St. Gothard tunnel. This line would entirely avoid Switzerland. The route from Munich would pass by Fern, Landeck, Reschen, Trafoi, Bormio and Lake of Como to Milan and Genoa.

WEST AFRICAN RAILWAYS are reported by Reuter's Agency as progressing as follows: The Sierra Leone Railway is completed to Songo Town, requiring the erection of eleven steel viaducts, and is now being pushed on to Rotofunk. At Lagos 7,000 men are at work beyond Abbeokonta towards Ibacian, and the rails will be laid to the former place in a few weeks. The Tarkwa Railway, in the Gold Coast Colony, is progressing; a jetty has been built to facilitate landing at the port, shops, stores and barracks have been constructed, and the final survey is about completed. On all these West African railways about 10,000 men are at work.

THE HUDSON RIVER TUNNEL CO. is showing some signs of life again. It is reported that Horace E. Golding and John Young, of London, and Daniel Lord and Francis B. Jennings, of New York, are actively engaged in plans for resuming work. Chancellor McGill, of New Jersey, on March 8, directed Randolph Parmley to sell the property under an execution for $3,916,894 granted in the foreclosure suit of the bondholder trustees, and the New York authorities have granted similar power. This action will enable the company to be reorganized, as the tunnel property will be bought by the committee. No estimate is published of the cost of completion, but the committee express the belief that the improvement in methods of submarine tunnelling, since work was abandoned, will enable them to push it through. The firm of Sooysmith & Co. is to report upon it.

THE EAST RIVER TUNNEL of the New York & Long Island Ry. Co., commenced in 1892, and abandoned, is again being discussed. The plans call for a tunnel under the East River, from 4th St., Long Island City, to some point near 42d St., Manhattan, large enough for four tracks. It would be 30 ft. high by about 40 ft. wide, and the East River is about three-fourths of a mile wide at this point. The estimatel cost of the work is $25,000,000 to $30,000,000. A tunnel under Manhattan Island and the North River, to Jersey City, was part of the original plan. Mr. Malcolm W. Niven, President of the Construction Co., and Secretary of the New York & Long Island Ry. Co., is said to be now in England attempting to raise capital for carrying out the work.

THE PORT ARTHUR SHIP CANAL will be completed by March 20, according to press accounts. This canal was commenced in 1896 on plans drawn up by Mr. Robert Gilham, General Manager and Chief Engineer of the Kansas City, Pittsburg & Gulf Railway Co. It is intended to extend deep water from Sabine Pass to Port Arthur, with a depth of 25 ft. throughout. It is 7½ miles long, and its construction involved the dredging of 14,000,000 cu. yds. of material.. Full details of this canal were published in Engineering News of Feb. 17, 1898.

THE CHICAGO DRAINAGE CANAL WATER POWER has not yet attracted any bidders, notwithstanding its very attractive features, which we noted in our issue of Feb. 23. Apparently the lack of competition will enable some enterprising bidder to secure the lease of the power at a price which will enable him to make a handsome fortune from its development. The profitable market which awaits the development of this power makes it a far more attractive proposition than anything which has been developed at Niagara.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Burlington & Missouri River R. R., on March 11, near Lincoln, Neb. There was a blinding snow storm raging at the time, which prevented signals being seen, and caused two engines to collide head on. Four men were killed and several were injured.

A SERIOUS RAILWAY ACCIDENT is reported to have occurred on March 12, near Rakaia, on the Rakaia River, South Island, New Zealand, in which two excursion trains collided, killing 5 persons and injuring 40 others.

THE STEAMER "CASTILIAN," of the Allen Line, bound from Portland, Me., for Halifax, N. S., and Liverpool, went ashore at Gannet Rock Light, near Yarmouth, N. S., on March 12. It is stated that her compasses were out of order, and the dense fog prevailing at the time prevented the lookout seeing the light-house. Later reports state that an important buoy off Seal Island, used as a starting point by Transatlantic vessels, went adrift on March 10 and is responsible for the disaster. No casualties are reported, the passengers all being removed and landed at Halifax. The "Castilian" made her maiden voyage about 10 days ago, and was considered one of the finest of the Allen fleet. She was built at Belfast, Ireland, and was of 8,200 tons register. She was 470 ft. long, 53¾ ft. beam and 36 ft. deep. The value of the vessel is placed at $700,000, and the cargo at $450,000. Efforts are being made to save the vessel.

YELLOW AND GREEN SIGNAL LIGHTS have been adopted for the "clear" indication by the New York, New Haven & Hartford R. R. as substitutes for white lights. The home signals will show a red light for "stop" and a green light for "clear." The distant signals will show a yellow light for "caution" and a green light for "clear." This will make the distant signals distinctive, without the use of two lights or lenses for one indication, as on the Chicago & Northwestern Ry., which uses a combination of red and green lights for "caution" on the distant signals. On the N. Y., N. H. & H. R. R. the arms of the distant signals are painted yellow with a black stripe, which is more easily seen than the green and red arms used in C. & N. W. Ry. practice. The change is a result of the accident at Whittenton, Mass., Sept. 6, 1898, in which an engineer mistook the white hand lamp on a raised crossing gate for a white home signal. The home signal was at the "stop" position, but its lamp had been extinguished.

TEN-WHEEL EXPRESS ENGINES are being built at the works of the Northeastern Ry., of England, and will be the first English passenger engines having more than four driving wheels, although the Highland Ry., of Scotland, has used ten-wheel engines for some years. The new engines will have outside cylinders, 20 × 26 ins.; and driving wheels 6 ft. 1½ ins. diameter; with very large boilers and fireboxes. The engines are intended for the heavy trains which now have to be run as double-headers.

WIRE-WOUND GUNS are dealt with by the Royal Gun Factory, of England, in a late addition to the Service Treatise on Ordnance. The use of wire, or flat ribands, enables a gun to be made that with a given weight has more strength, thinner walls and greater length, and enables a higher velocity and more energy to be given to the projectile than with the built-up type. The ordinary 12-in. gun, for example, was 328½ ins. long and delivered its 850-lb. projectile with a muzzle velocity of 1,915 ft. seconds, and a striking energy of 18,139 ft. tons. The wire 12-in. gun is 445½ ins. long, delivers the same projectile with a velocity of 2,367 ft. seconds and a striking energy of 33,020 ft. tons. The London "Engineer" mentions a new 12-in. wire gun from which 2,600 ft. seconds velocity and 39,850 ft. tons of energy are expected.

A 5-IN. BROWN SEGMENTAL TUBE WIRE-WOUND gun, being made at Birdsboro, Pa., for the government, is being tested by government officers at that place, up to 500 rounds. The gun weighs 3½ tons and is 19 ft. long; and up to the present time the maximum pressure exerted has been over 30,000 lbs. per sq. in., imparting a velocity of nearly 3,000 ft. per second to the projectile. Twenty-five of these guns have been ordered, and 25 others of 6-in. caliber. These last weigh 10 tons each and are intended for coast defence. A 10-in. gun of the same type is also being built at the Scott Works, in Reading, Pa., to be tested in July. The 6-in. guns will cost $10,000 each, according to the press accounts.

U. S. WARSHIPS to the number of 55, says Rear Admiral Hichborn, Chief Naval Constructor, in his last report, are under construction or actually contracted for. The degree of completion of the larger vessels is given as follows: At Newport News, the battleships "Kearsarge," 85%; "Kentucky," 83%; "Illinois," 62%. At the Cramp Yard the battleship "Alabama" rates at 76%; and at the Union Iron Works, San Francisco, the battleship "Wisconsin" rates at 63%. The other battleships contracted for, the "Maine," "Missouri" and "Ohio," were not commenced at the date of the report. The sheathed cruiser "Albany" is 80% finished, and the torpedo boats and other vessels under way from 0% to 94% finished.

U. S. EXPORTS FOR FEBRUARY 1899, says the U. S. Bureau of Statistics, as shown by the preliminary reports, aggregate in value $55,969,894, as compared with $49,843,806 in the same month of 1897. The month of February, 1898, however, showed $62,009,536, the largest February on record. But the Bureau says that the last return does not show a falling off in volume, but a slightly lower price for some of the leading articles exported. As, for example, nearly 10,000,000 bushels of wheat were exported in February, 1899, against 7,000,000 in the same month of 1898; while the value is given at $7,335,390 and $6,434,028, respectively.

AN INVESTIGATION OF STREET RAILWAY SYSTEMS will be made by the Highways Committee of the London County Council, preparatory to adopting some improved method of operating the city tramways. For this purpose, it is understood, Prof. A. Kennedy, F.R.S., has been selected as consulting engineer, to collect information respecting the various mechanical systems of traction other than steam or cable, and to give expert advice in connection with installing an experimental line.

NOTES ON THE OPERATION OF THE SEWAGE FILTER BEDS OF PLAINFIELD, N. J.

The sewage of Plainfield, N. J., has been treated by intermittent filtration since the sewerage system was put in operation, about three years ago.*

The operation of the plant has gone on very smoothly, except for difficulties caused by the flooding of the beds during sudden rises of the ground water level along one of the main sewers, to which further reference will be made.

There are now 19 beds in use, with a combined area of about 16 acres. Most of the beds are composed of sand having an effective size or diameter of 0.20 to 0.25 mm. (0.008 to 0.01 in.). The beds are underdrained.

In both 1896 and 1897 good corn was raised on the filter beds. In 1898, the head laborer at the beds agreed to take care of them for $3.00 a day, furnishing all necessary labor, provided he be given the privilege of cropping the beds. The flooding, mentioned above and below, killed three separate plantings of corn, except on one bed. Unless the ground water is reduced, further attempts at cropping the present area will be entirely out of the question. The city owns 51 acres of land, or about three times the present area in beds, but is averse to preparing additional beds, since they would be nearer than are the present ones to a number of houses in the vicinity, some of the occupants of which are already opposing the use of the present area. The keeper of a summer boarding-house already has a suit pending against the city for $10,000 damages, alleged injury to her business and property. A boarding-house much nearer the beds was well patronized, however, during the summer of 1898.

Until September, 1898, the sewage was screened before passing to the beds. The resulting sludge was run onto small beds, which, it is said, were always the most objectionable feature of the plant. It was concluded that the better place to handle this material (consisting for the most part, of paper) is on the large beds with the rest of the sewage; most of the deposit is found near the distributing channels, and as the water leaves it, air-slaked lime is sprinkled over the portions likely to become offensive. It is said that little if any additional labor is caused by handling the sludge or scum in this way, and the annoyance and trouble caused by the former system are saved.

The accompanying views show some of the beds as they appeared in October, 1898. Fig. 1 shows one of them flooded; Figs. 2, 3 and 4 show other beds at different stages of the operation: ready for raking; rakings in heaps ready for carting away; and a bed prepared for a new dose.

With some 1,200 houses connected with the sewers, the quantity of water reaching the beds during 1898 varied from about 550,000 to 1,000,000 gallons per day. The proper dose for the Plainfield beds is placed at an average for each of 30,000 gallons per day; that is, a bed should be given about 150,000 gallons, then a rest of five days. The flow measured on Oct. 1, 1898, was 28,000 gallons per hour, consequently each bed at that time could have been flowed between five and six hours in the day time and longer at night. In January, 1899, the maximum flow reaching the beds after rains was 1,250,000 gallons.

There is a large volume of underground water in the sand and gravel beneath portions of the city. Along one of the main sewers, 12 ins. in diameter, the ground water level in January, 1896, was 9.3 ft. below the surface. It remained low, for the most part, for many months, but in May, 1898, it rose after continuous rains to within 4 ft. of the surface. This rise and its effects are described in the reports of the street committee of the city council for 1898, as follows:

> Last spring the continuous rain caused the ground water in the eastern part of the city to rise from 3 to 6 ft. higher than it had been for years, submerging some of the sewers which before had been above water. This revealed the fact that all the damage caused by the explosion of illuminating gas in the fall of 1895 had not been reached, for the 12-in. pipe in Richmond St. ran full bore for some time. In addition to the leakage of ground water, the water supply company pumped some 145,000 gallons of water per day more than last year, so that a very large quantity of water, about 1,000,000 gallons per day, was sent to the disposal beds. Free sewers, and water paid for by the tap tend to great wastefulness and extravagance, and a large percentage of the flowage in the sewers is clear water.
>
> Steps were taken as soon as possible to locate and repair the leaks, and some 1,300 ft. of sewer were examined by excavation down to the pipe; most of it was [illegible] condition, but a length of 140 ft. of 12-in. pipe [illegible] mond St. was found to be entirely shattered, though retaining its form and carrying the sewage.
>
> During this work the ground water gradually s[illegible] so that it could not then be determined whether [illegible] placing of this broken section would stop most [illegible] leakage or not.
>
> As the flow diminished, each bed in succession w[illegible] drawn from use until it was dry enough to be put [illegible] order again; two additional beds were filled wi[illegible] underdrains were laid in two beds not previously p[illegible] with them, and an 8-in. intercepting drain was [illegible] to divide the underdrain systems into two parts.
>
> During the pleasant summer and fall weather th[illegible] continued to improve until October, when they w[illegible] excellent order. This favorable condition continued [illegible] the wet weather in the latter part of November and [illegible] of December, when the rain, snow and ice cover[illegible] the beds from sight.

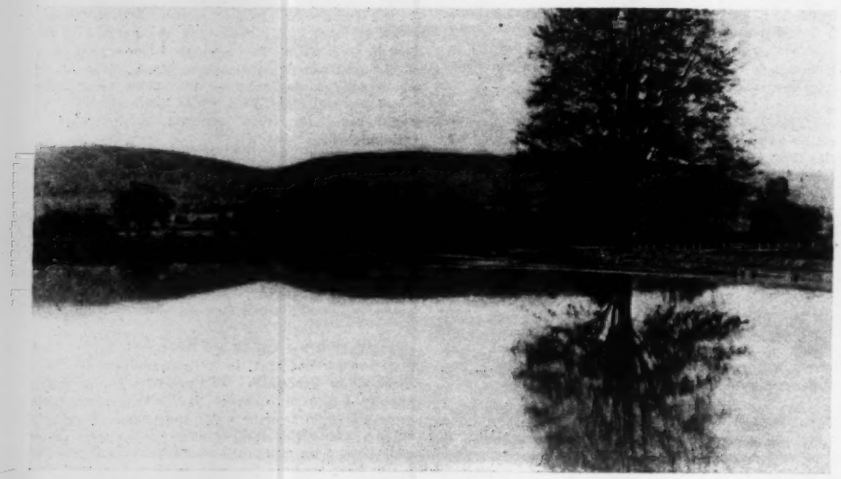


FIG. 1.—SEWAGE FILTER BED NO. 6, AT PLAINFIELD, N. J.; FLOODED WITH SEWAGE.
A. J. Gavett, Engineer-in-Charge of Sewers.

Heavy rains in the latter part of January, 1899, again filled this sewer, backed up the sewage and ground water in the manholes and flooded the beds. Some damage was done to one of the division embankments, and at one point an outer embankment was overtopped, so that for a few hours sewage was discharged into some swampy land adjoining the brook which receives the effluent from the beds.

On Feb. 2, a member of the editorial staff of this journal visited the beds. Most of them were then covered with snow and ice, and some were filled to the top of the division embankments. A bed, which had received sewage four days previously, had 7 ins. of sewage upon it, beneath 4 ins. of ice. At times, it was learned, some of the beds had been covered with a solid layer of ice.

Observations and gagings show that the bulk of the infiltration is through some 1,700 ft. of 12-in. vitrified pipe sewer. This pipe is paralleled by a 4-in. underdrain, but under existing conditions so small a drain is of no practical value. After careful studies on the part of the sewer committee, of Mr. A.J. Gavett, Engineer-in-Charge of Sewers, and after consultation with Mr. F.W. Farquhar, of New York, the city council decided to call for bids (to be received March 13) for replacing 1,624 ft. of 12-in. and 630 ft. of 10-in. vitrified pipe with cast-iron, and of providing 8 to 15-in. underdrains for a part of this section. (See "Contract Prices" in Supplement.)

The cost of operating the whole sewerage and sewage disposal system of Plainfield during 1898, including repairs and new work at the beds, is given in the report of the sewer committee as follows:

Engineering	$313
Labor on disposal beds	1,35[illegible]
Tools and supplies	15
Repairs to sewers and appurtenances, etc.	5[illegible]
Water and labor, flushing	54[illegible]
Inspecting connections and advertising	1[illegible]
Total	$3,21[illegible]
Two new beds, new drains and repairs	$1,95[illegible]

FIG. 2.—BED NO. 4; SLUDGE DEPOSIT SPRINKLED WITH LIME, READY FOR RAKING.

The members of the Committee on Streets and Sewers are as follows: E. T. Barrows, J. Van Herwerden and R. I. Tolles. We are indebted to Mr. Gavett for courtesies extended and information given in connection with the preparation of this article.

*See Eng. News, Sept. 10, 1896, for a full illustrated description of the sewerage and sewage disposal systems.

ADJUSTMENT OF ERRORS IN THE RESURVEY OF ROANOKE, VA.

By Wm. M. Dunlap, C. E.*

In order to comply with the state law requiring correct maps, the city of Roanoke, Va., about eight years ago, undertook to make a resurvey of the entire area of the city, about 3,500 acres. The work was done in compliance with carefully prepared and well approved specifications, requiring the retracing as nearly as possible of the original survey lines, the planting of permanent monuments for their preservation and making a complete topographical survey and maps for the use of the enginering and tax departments. The true meridian was taken as the standard of direction, and the U. S. government standard for linear measure was used.

FIG. 3.—BED NO. 12; RAKING OFF SLUDGE DEPOSIT. (MORE DEPOSIT THAN USUAL.)

The first step was a basic triangulation survey, a report of which by the engineer-in-charge was published in Engineering News, Jan. 9, 1892. The next step was a traverse survey of each block, with a limit of error of 1 in 10,000, on which as a base the topography was taken, locating all existing monuments, buildings, fences and other objects deemed of importance. In the search for the original landmarks, excavations as deep as 8 ft. were sometimes made, where the ground had been filled over. Then abstracts of all deeds of transfer were made, systematically filed and plotted on transparent paper to the same scale as the detail topography sheets. By placing the former over the latter a comprehensive study was quickly afforded and assisted in determining or confirming the location of street and property lines.

At this stage of the work a valuable paper on the methods employed was read by Mr. G. P. Wood, the Engineer-in-Charge, before the Association of Engineers of Virginia, and published in its "Transactions" for July, 1891, to March, 1893.

After the street lines had been located and the stone monuments set on 5 ft. offset lines at each angle in a block, the final step was to locate the individual lot lines. It is probable that in no other place does there exist such a confusion of property lines as was shown in the attempt to plot certain blocks in this city, and this last step was approached with some misgivings as to a satisfactory solution of the difficulties. There was usually found a discrepancy between the actual block measure and that shown by summing up the abutting lots as per deeds; sometimes inappreciable, but in some instances as much as 0.3%, or nearly 1 in. in 25 ft. The plotting, chronologically, of the lots of a block illustrates the character and extent of the irregularities. When there was no positive evidence of the exact location of lot monuments within a block, the discrepancy, either surplus or shortage, was apportioned among all the lots in the block.

Indications in many instances pointed plainly to error of standard measure as the chief cause of the discrepancy. It is well known that measuring tapes vary considerably in length, and that the effect of temperature is appreciable. Thermometers were used on the traverse survey and corrections for temperature were made.

Under such circumstances and for the following reasons it was deemed advisable to eliminate all error in a block by the method of apportionment:

(I.) It complies with the first principle of surveying.

"A survey must close in some way or other." Doe vs. King, Howard, Miss., 125. "The object sought is not to perpetuate forever the blunders of the original survey, but to seek the most rational adjustment of all the evidence, so that all parts may be located with a minimum of conflict."

(II.) It is consistent with the intention of the original seller of the block of lots, who made no reservation or guarantee as to surplus or shortage.

"Where boundaries are inconsistent with each other those are to be retained which best subserve the prevailing intention." 7 Vermont, 511. "When the same grantor conveyed to two persons, to each one a lot of land, limiting each to a certain number of rods from opposite known bounds running in a direction to meet if extended far enough, and by measure the lots do not join, when it appears from the same deeds that it was the intention that they should join, a rule should be applied which will divide the surplus between the grantees in proportion to the length of the respective lines as stated in the deeds." Lincoln vs. Edgecomb, 28, Maine, 275.

(III.) It causes the least disturbance and is just and fair to all alike.

"Surplus or deficiency does not invalidate a conveyance." "Surplus or shortage in a block is to be divided pro rata between the lots." Newcombe vs. Lewis, 31, Iowa, 488:

(IV.) It recognizes a much neglected fact—erroneous standard of measure, and makes the correction by applying the legal standard.

* * * "The rule of common sense and of law is that the surplus or deficiency is to be apportioned between the lots, on the assumption that the error extended alike to all parts of the block."—Judge Cooley.

The above references are from Johnson's "Surveying," and Hodgman's "Surveying."

The portion of the survey which was thus completed has been constantly used and strictly followed in locating lot lines. The city having received the fees and issued its certificates therfor is bound to sustain its officials and defend the locations thus established. The survey was suspended about four years ago for lack of funds. It had cost about $20,500, and it was estimated that about $3,000 more would then complete it. This would be $7 per acre, or $2 per lot. This is briefly the history of the survey as made.

About a year ago, in an endeavor to resume the work, the method of apportionment of the shortage or surplus was criticised as incorrect and illegal; it was stated that important data had been omitted in abstracting, and that the survey was extravagant in cost. The presentation of these criticisms may be of interest and throw some light on the subject of cadastral surveys, so sparingly treated in the text books.

At the present time the young surveyor is more interested on following the magnetic needle and the rules of geometry than in obtaining and weighing all available evidences of so-called lost monuments. Indeed, we sometimes find an experienced surveyor endeavoring to relocate a lost monument without corroborative evidence; in other words, he tries to place it where it should have been instead of where it actually had been; or, worse yet, he sometimes alters the location of old existing monuments to suit the description of the one tract being surveyed, or according to a plan or system of uniform geometrical figures. Professor Raymond says, "A resurvey, after the original monuments have been lost, is for the purpose of finding where they were and not where they should have been."

After the succeeding City Engineer had made use of the survey for several years as official, he made a report to the council on Dec. 4, 1897, by request, from which I abstract as follows, referring to the official map:

I have discovered that the method of determining property lines is, in my judgment, incorrect. I am of the opinion (and I am borne out in it by the opinion of lawyers) that the map should show the true line as indicated by deed, and whenever lines lap or do not connect they should be shown on the map. Instead of this being done the lines have been adjusted so as to make all of them coincide, which makes entirely new lines in many cases. * * * *

As to the field and office work, I found no errors, and presume that the map is correct, except in the method of determining lines, as cited above. * * * *

As to the cost of completing it, I am unable even to approximate, as snags will constantly occur which will require much more time to work out than can be estimated.

FIG. 4.—BED NO. 16; HARROWED AND READY FOR FLOODING.

The City Solicitor, under date of Jan. 24, 1898, in response to a query from the city council said:

*Late City Engineer of Roanoke.

I am clearly of the opinion that neither the City Engineer nor any other authority has the right to take from or add to the land which properly belongs to any individual. If the aggregate frontage of lots upon a particular block is less than the measured distance embraced in said block, then such excess either belongs to the original landowner, or may have attached, by virtue of some conveyance, to some particular individual.

About this time the Grand Jury threatened council with imprisonment for not complying with the requirements of the code as to an official map, and in the course of the proceedings the following communication was submitted by the former City Engineer:

As requested, I will endeavor to explain the methods employed in adjusting the lot lines in a block and the reasons therefor.

The object of the work was to retrace the original survey and to make the most rational adjustment of all conflicting evidence. Three principles were recognized in this work:

1. That original monuments govern.
2. That the U. S. standard is our legal measure.
3. Overlaps and vacancies within a block are inconsistent with the intention of the seller of the ground.

In accordance with these principles diligent search was made for evidences of the original survey, standard measure was used, and the lot lines were so regulated as to completely fill the block without overlaps or discrepancies. The last principle is what I understand you wish explained, which can perhaps be more plainly done by a simple example of a block 400 x 100 ft., which has been divided into eight lots, each 50x100 ft. The block boundaries measured by legal standard are found to differ from the recorded plot, we will say, by one foot more in front and one foot less in rear, and half a foot more on one end and half a foot less on the other end. The monuments being correct must govern, and cannot be moved to correct the distances, any more than if they were trees marking the land. The error exists and must be disposed of. This part of the work presents a judicial feature, and, what is a fair divide of the error, or what is the limit of the right of possession, become pertinent questions. In the example, the owner had the block divided into eight equal parts of 50 ft. each; it would seem fair that each lot would then be one-eighth of the actual measure by correct standard—that is, one-eighth of 401 ft. in front and one-eighth of 399 ft. in rear, etc. The following authorities are applicable:

However erroneous may have been the original survey, the monuments that were set must nevertheless govern. On town plots, if a surplus or deficiency appears in a block, when the actual boundaries are compared with the original figures, and there is no evidence to fix the exact location of the stakes which marked the divisions into lots, the rule of common sense and of law is that the surplus or deficiency is to be apportioned between the lots, on the assumption that the error extended alike to all parts of the block.—Judge Cooley of Michigan Supreme Court.

Surplus or deficiency does not invalidate a conveyance.—Johnson's Surveying, Rules fr. Court Decisions.

The survey was given the title "official" because it was to be made by an officer of the city, chosen by its council, under authority of the charter. It cannot and does not undertake to establish lines, but it did undertake to retrace as near as practicable the original survey and represent the same on maps. When this is accepted by those interested, either willingly or by litigation, it becomes established and not before. An engineer cannot establish a monument or line; he can only act as an expert witness and furnish all the facts obtainable in an impartial manner. The owner must acquiesce or litigate before final settlement.

There were two reports to council by the committee. The majority stated that

* * * "The committee did not consider the rights and prerogatives of the Grand Jury in the matter, * * * and * * * does not feel that it would be expedient to appropriate further sums for this purpose." * * *

The minority report was as follows:

Your committee herewith submits the reports of the city engineer and the opinion of the city solicitor in regard to the official map; and your committee is of opinion after investigation that said report is correct in its reference to the inaccuracy and illegality of the methods employed heretofore in the official map in determining the lines of property and apportioning the excess or the shortage in the block, as the case may be. Your committee is further of the opinion that with this exception, in the main, the map is correct; and that by re-checking the surveys already made, the city engineer, or some other engineer employed for the purpose, could go over the map and show by replatting, in some cases, where the excess or shortage in frontage, as the case may be, is; thus avoiding a resurvey of the blocks that have been ascertained to be accurate according to the deeds. The abstracts from the deeds which have been taken and the surveys which have been made, and generally speaking the work which has been done on the map is correct, and can be used, with the following exceptions: 1st. In taking abstracts from the deeds the former city engineer has failed to take note of any of the deeds of trust which have been foreclosed, through which the title consequently passed, the same as in cases of deeds of bargain and sale. 2d. In dividing up and platting the property showing the various owners thereof, the engineers in charge have undertaken to apportion the surpluses or shortage ratably among the various owners, between two established streets, instead of showing which owner is entitled to such excess or which must suffer the shortage, as shown by the various deeds. This is illegal and in violation of the vested rights of the owner, as is shown by the opinion of the city solicitor herewith filed. * * * But notwithstanding the fact that the plan of the map is more elaborate and expensive than necessary for a city of this size, yet, considering that most of the work has been done and only the platting, re-checking and verification of the records and the establishment of some of the monuments, which have rotted out, your committee believes it will be cheaper to complete the present map than to abandon it and attempt to make a new one on a different plan.

While the matter was under consideration the manager of a guarantee title company in the city appeared before council and made a statement relative to the map. The abstract system of this company was examined by the City Engineer, who then recommended that the city pay this company $10 a block for the temporary use of its system, as it contained certain essential data which had been omitted in that prepared by the survey. This would cost, at that rate, about $6,000 for the whole city. This, however, was a gross mistake, for examination will show that the matter referred to was not omitted, but was at that time on file in order with the whole abstract system.

It will not be unfair to say that the methods proposed in the attempt to resume the work would be prejudicial to the public interest. For it would be wanton waste to pay money for data already in possession; it would be unjust to the engineering profession to call this an extravagant survey, and the substitution of a method of manmaking which would show confusion without correcting error would only serve to perpetuate blunders and cause useless litigation. In fact, this plan would prove an impossibility, since it would recognize all deeds to be correct, and this would prove the new monuments now set to be incorrect, yet these have already been acknowledged as correct. Furthermore, the method proposed is supported only by mere individual assertion. In view of the facts presented in this controversy, it is fortunate that council refused to appropriate funds for the change proposed, which would have caused the mutilation of that portion of the map already completed and the shifting of lines which have been given by the survey and which have been used as limits to new buildings, or have been incorporated in deeds of correction in important transactions.

The following is a sample of a foreclosure deed, which was abstracted and filed with other transfers. As it is a useful form in similar cases, it is given, as follows, filled out for a special case:

OFFICIAL SURVEY, ROANOKE, VA.

Range E. Section 7.

Date (Mo., Aug. Day, 24, Yr., '93). Deed Book 89, p. 146.

From L. H. Cocke et al, Trustees, to Old Dom. B. & L. Assoc of Rd., Va. Beginning at s. e. cor. Jefferson St. and Gainsboro Road; thence with latter N. 67° E. 54.5 ft. to a point; thence S. 2° W. 172 ft. to an alley; thence with sd. alley N. 88° W. 50 ft. to Jefferson St.; thence with same N. 2° E. 150 ft. to beginning.

WATER POWER PLANTS WITH LONG-DISTANCE ELECTRIC TRANSMISSION IN SOUTHERN CALIFORNIA.

II.

By C. E. Fowler, Assoc. M. Am. Soc. C. E.

(With full-page plate.)

The first plant to be constructed in Southern California for the long-distance transmission of electricity generated by water power was that of the San Antonio Electric Light & Power Co., which transmitted electric current from San Antonio Canyon to Pomona and San Bernardino.

The water for operating the generating machinery of this plant is diverted from San Antonio Creek by a concrete dam into a short canal, from which the leaves and rubbish are removed by a traveling screen, operated by a small undershot wheel. From the canal the water is carried to the power house by a pipe line about 5,000 ft. long, with a number of inverted syphons, and with blow-off valves and air valves. The diameter of nearly half the pipe is 20 ins., and the balance is 30 ins., the head being 475 ft.

The site of the power house is blasted out on a rocky mountain side, about five miles from the mouth of the canyon. The building is 36 x 70 ft., with heavy concrete walls, while 10 ft. of a raceway is cut off by a 24-in. concrete wall to contain the receiver and the Pelton water wheels. While there is room for four wheels, two only have been installed. They are 34 ins. in diameter, direct-connected to 120 K-W. Westinghouse alternators, each of which delivers current to 20 6 K-W. step-up transformers. These deliver current to the line at from 10,000 to 11,000 volts. There are also two 14-in. Pelton wheels to operate the 90-ampere exciters.

The line consists of two single-phase circuits of No. 7 B. & S. bare copper wire extending south eight miles, from which point one branch, seven miles long, extends southwest to Pomona, and the other east 22 miles to San Bernardino, making one circuit of 15 miles and one of 30 miles. The stations at both places contain only banks of step-down transformers and Stillwell regulators, the current being delivered to the local lines at 1,000 volts. The plant was put in operation in November, 1892, and was at the time of its construction the longest electric transmission line in commercial operation.

The next important enterprise undertaken in this field was that of the Redlands Electric Light & Power Co., which takes water from Mill Creek, and transmits current to Redlands, Colton and Riverside. The diversion works on the stream consist of a small masonry dam and cement conduit, leading by a tunnel 160 ft. long to the penstock. From this a 30-in. pressure pipe extends 10,250 ft. to the receiver at the power house, which sustains a static pressure of 230 lbs. The power house is of concrete, 24 x 80 ft., with wooden roof. The four 36-in. 400-HP. Pelton wheels are located just outside the power house, as are also the two 13-in wheels for running the exciters. There are four 250 K-W. General Electric generators, which are said to be the first three-phase machines built in the United States, they run at 600 revolutions, and deliver current at 2,500 volts.

There are three circuits of three wires each, one four miles long and one 7½ miles to Redlands, both of which use current direct from the bus bars of the switchboard, while the third carries current at 11,000 volts a distance of 22 miles to Riverside, with branches to a point near Highlands and to Colton. For this purpose there are installed at the power house four Wagner 100-K-W. oil-filled, and water-cooled, step-up transformers. These raise the potential from 2,500 volts to 11,000 volts. The same make of transformers are used for stepping down the pressure at Colton and Riverside. Near Highlands and at other points General Electric natural draft transformers are used. The plant was put in operation in September, 1893, and is at present engaged in the development of additional water supply, and will increase its plant to about double its present capacity. Until these improvements are completed, it is using additional current from one machine at the power house of the Southern California Power Co., described last week.

The new plant of the San Gabriel Electric Company, at Azusa, was completed on July 1, of last year, and is in many respects the most interesting one in Southern California, as the company has three sources from which it can draw its power. The primary plant at Azusa, as well as the station in Los Angeles, are on the Westinghouse system.

The generators at the power station are four 300-K-W. Westinghouse two-phase machines, while at the power station in Los Angeles is an auxiliary 300-K-W. rope-driven generator, the engine being supplied with steam from boilers using oil fuel. In addition to these two sources the company has wire connections by which current can be given to or taken from the Los Angeles street railway plant.

The water supply of the Azusa plant is obtained from the San Gabriel River, through a canal line 5.93 miles in length, of which 66% consists of tunnels, 38 in number, the longest being 1,610 ft. The remaining distance comprises 28%

of 48-in. redwood stave pipe, 5% of concrete culvert, and the balance of steel pipe curves connecting the wooden pipes.

The temporary diversion of the stream is effected by a wooden flume, which carries the water to a masonry intake seen in the background in Fig. 2. This is protected by a grating of old railway rails. Just beyond the grating is a drop of about 20 ft. to the mouth of the first tunnel. The permanent diversion will be effected by a concrete submerged dam just below the intake, of 400 ft. radius, and a top thickness of 6 ft., on a level with the bed of the stream, so that the torrents of the rainy season will pass over without damage. Removable wickets will be used on top of this in the dry season. Test pits have been sunk, eight in number, a distance of 50 ft. apart to bed rock, and can be seen in Fig. 2. Six of these pits reached bed rock at an average depth of about 20 ft., while the other two have been abandoned until the dry season next year at a depth of 50 and 52 ft., it being expected that bed rock will be found at less than 60 ft.

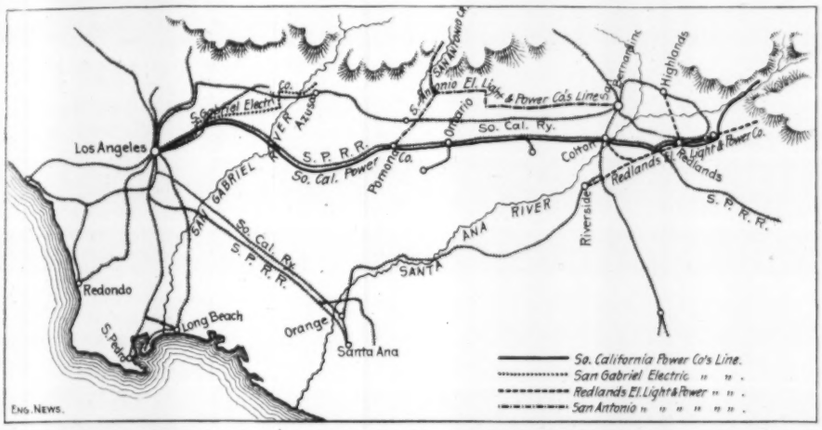


FIG. 1.—MAP SHOWING THE PRINCIPAL ELECTRIC POWER TRANSMISSION LINES IN SOUTHERN CALIFORNIA.

There will be a tunnel about 20 ft. below the surface, along the face of the dam, to collect the water and deliver it to the intake at this level, which is the reason for the vertical drop noted above. The present flow of about 1,200 ins. will be increased by about 1,000 ins. by the completion of this dam.

The canal tunnels have a finished width of 4 ft. 9 ins., being lined with concrete, with a minimum thickness of 4 ins., and where the natural rock roof was not safe they are arched with a height of 6 ft. from the floor to the crown of the arch. At the ends of the tunnels the line drops to 10 ft. below hydraulic grade, so that the wooden pipe is kept full at all times.

The wooden pipe (Figs. 3, 4 and 5), is 48 ins. in diameter, and is made of redwood staves 1¾ ins. thick and 6 ins. wide. The edges are planed, and the ends joined by metal tongues, the staves being built to break joint. The pipe is bonded every 8 ins. with iron bands ½-in. in diameter. The bends are made with short sections or elbows of No. 8 steel pipe, 2 ins. larger in diameter than the wooden pipe. The space between the two is first packed with oakum, and then filled full of cement mortar. Where the pipe enters tunnels its bottom is placed about 10 ft. below the tunnel grade, and the connection between the tunnel and the pipe is made through masonry manholes with inclined floors. The slope of the mountain side is very steep, 30° to 60°, and for this reason a flume was considered unsuitable, as every rain is likely to loosen rocks and bowlders scattered on the mountain side above the grade line. The pipe is laid for the most part in the loose, loamy material, intermixed with rocks and bowlders which covers the mountain side.

After the pipe was completed, and before the water was turned on, a large rock rolled down the mountain and crushed a section of the pipe. As the pipe was empty, the repair was a trifling matter; but had it been in use conveying water to the power station, the interruption to the service would have been serious. To guard against disasters of this sort in future, the pipe line has been covered where covering was possible.

When the water was turned into the pipe some small leaks developed at various points, due partly to the settlement of the material under the pipe and partly to the movement of the steel elbows, which were not anchored to secure them from movement under the thrust of the water. These elbows have now been anchored and the pipe made tight from end to end. Experience indicates, however, that it would have been advisable to have expended a larger amount in side-hill excavation to bring the pipe upon a firmer foundation and protect it from material rolling down the mountain side.

The gradient of the tunnels is 0.1%, and of the pipe line 0.206%, making an average grade of 0.13% for the entire line. The sand is removed by a sand-box similar in construction to the one described in the preceding paper on the Southern California Power Co.'s plant, and also by blow-off valves at the lower end of all sections of the pipe line.

The flume line terminates in a concrete forebay, located on the mountain side, about one mile north of Azusa, near the mouth of the canyon. From here a steel-riveted pipe, 36 ins. in diameter and 827 ft. long, extends down the very steep mountain side, which has in some places an inclination of 50°, and terminates in the receiver at the power house, making a turn at the bottom of 90°, with a radius of 50 ft. The static head of the power house is about 400 ft. The thickness of the pipe varies from No. 11 gage at the top to 15-32-in. at the bottom. The top section, which is cemented into the concrete chamber, is bell-shaped for a length of 72 ins., with a top diameter of 48 ins. There are two 6-in. air valves on the line, and the pipe is anchored by concrete to the rock in seven places.

The receiver, 40 ft. long (Fig. 6), is placed alongside the four water wheels. It is 48 ins. in diameter, and is made of ½-in. steel with riveted joints. It has two 3-in. spring relief valves, and a 4-in. blow-off at the lower end. The branches which deliver water to the nozzles, are at right angles to the receiver, while the nozzles are at right angles to these in turn, or parallel to the receiver, masonry being built at the ends of the branches in such a way as to take up the thrust.

The wheels are of the Tuthill impulse type, and each unit of 550 HP. is in reality two separate wheels on the same shaft, each one having its own nozzle. The buckets are set at an angle to one side of the center, alternately right and left, so that the water from the nozzle strikes the bucket without being divided, and leaves the bucket with a low velocity. Each shaft is provided with a 3-ton flywheel, the speed being 430 revolutions per minute. The connection to the generator shaft is made by a disk or head on each shaft, which carries four pins, these pins being connected by sole-leather links, with a number of layers to a link. The regulation of the speed is accomplished by Tuthill governors driven by belt from the main shaft, and showing at the tests a variation in speed of seven or eight revolutions for a change in load of 20%. The efficiency tests of the Tuthill impulse wheels showed 84.1% under a head of 390 ft., with two 2⅝-in. nozzles, and an output of 394.6 HP.

The receiver and the wheels are in a lean-to adjacent to the power house, covered with a steel and galvanized corrugated iron roof. The valves are controlled by hand wheels located in the main room of the power house. The water, after passing the wheels, is discharged into a common tail-race, and from that into a reservoir (Fig. 7), which also receives the water of the spillway from the canal line. This water from the spillway is now carried in a temporary wooden flume, but work is in progress on a permanent flume which will discharge the water into a pit adjoining the reservoir, to break the fall down the steep mountain side, and from this it will flow into the reservoir itself. From the reservoir the water passes through small arched openings in the dividing wall to the reservoir of the measuring weir proper, which is provided with two weir gates of adjustable construction, so that the water can be exactly divided in proper proportion between the irrigation systems of Azusa and Duarte, the larger weir delivering the water to the former-named canal, and the smaller one to a wooden pipe line leading to the latter system. An automatic recording register is also provided which makes a record of the depth of the water in the weir.

The power house is built with monolithic concrete walls, having steel roof trusses covered with galvanized corrugated iron, and concrete floors. The walls have an offset near the top for the crane rail of the overhead traveling crane. A lean-to next the mountain provides space for the transformers and the high-tension switches.

The two-phase generators which stand adjacent to the walls on the water wheel side, are four in number, of 300-K-W. capacity each. Running at 430 revolutions, they deliver current at 500 volts. The exciters are four-pole 110-volt machines of 7.5-K-W. capacity, and are belted direct from the main shaft of the generator. For transmission the potential is raised to 16,500 volts by four 250-K-W. Westinghouse oil-cooled transformers. The length of the line to Los Angeles is 23 miles. It is built with Oregon pine poles, 50 ft. high in the city and 40 ft. high elsewhere. The top cross-arm is 6 ft. in length, and the bottom 8 ft. Locke glass insulators 5½ ins. diameter are used, and are screwed onto locust pins which were previously boiled in paraffine and painted. There are two three-wire circuits of No. 5 hard-drawn copper wire, arranged in equilateral triangles, each circuit being spiraled ⅓ at a distance of 7¾ miles from Los Angeles, and 7¾ miles from Azusa, but in opposite directions. The telephone line is placed below at a distance of from 3 ft. to 10 ft., alternately, to prevent induction, the two wires being also transposed every five poles.

The sub-station at Los Angeles is a brick building with iron trusses, corrugated iron cover and cement floors, and divided into three rooms. The main room containing the transformers and switch-boards, a second room the rope-driven generator and steam engine, and the third room the boiler plant. The current from Azusa is stepped down from the high tension used for transmission to different voltages for the various purposes required, by Westinghouse oil-cooled transformers, two of 125-K-W. capacity reducing to 2,400 volts, two of 150-K-W. capacity reducing to 360, 375, 425 or 460 volts, four of 125-K-W. capacity reducing to 218 volts, and two of 150-K-W. reducing to 2,400 volts, with four series transformers for regulation.

The current is then converted by means of Westinghouse rotary converters, from alternating to direct, before being turned into the distributing wires for use about the city. There is one 250-K-W. rotary converter taking alternating current at 360, 375, 425 or 460 volts, and transforming it to direct current at from 500 to 550 volts; two 225-K-W. rotary converters taking alternating current at 218 volts, and transforming it to direct current at from 220 to 320 volts; and one 400-K-W. rotary converter, transforming from 218 volts alternating to 220 to 320 volts direct current.

The rotaries are usually started up by applying current at the direct current side, starting them as

motors and by the process of synchronizing, using an incandescent lamp as an indicator they are brought into step, the alternating current is turned on and the machines are then essentially commutators for changing alternating current to direct.

The steam plant consists of a battery of 500-HP. water-tube boilers, using Los Angeles crude oil as fuel to generate steam for a 500-HP. Corliss engine, which drives the generator by rope transmission. The generator is a two-phase Westinghouse 50-cycle machine, running at 300 revolutions, and delivering current at a tension of 2,400 volts. The exciter is a 7.5-K-W. 110-volt machine, running at 1,300 revolutions and belted to the generator shaft. As it is proposed to install a second steam plant of 500-HP. capacity, in which the engine will, however, be a high speed one, and directly-connected to the generator, the reader may draw his own inference as to the relative cost of water power and oil fuel generation.

The combinations which are possible between the water power current delivered by the rotary converters, the steam power current from the auxiliary plant and the current from the street railway system, are almost without number, and require what is probably the most extensive switchboard system in existence for a plant of similar capacity.

The distribution is made through ducts constructed of creosoted lumber, instead of through Edison tubes, otherwise it is similar to that of the Edison Electric Co.

The writer's acknowledgments are due to Mr. A. C. Balch, General Manager and Electrical Engineer of the company, for courtesies extended and data from which this article has been prepared. Also to Mr. G. O. Newman, Civil and Hydraulic Engineer in charge of the water supply and canal work, for data and photographs. Mr. Newman is also engineer of the Riverside water supply. Mr. D. C. Henny, of the Excelsior Wooden Pipe Co., of San Francisco, favored the writer with the photographs of the wooden pipe line built by his company for the San Gabriel plant, which are reproduced herewith.

THE HALEY BUMPING POST.

A somewhat novel form of bumping post for dead-end tracks, which is now being used by several railways, is an all-metal post consisting of two A-frames, inclined together and carrying a buffer with coiled springs. Fig. 1 gives an elevation and plan. Each frame has its feet fitted to one of the track rails, to which it is secured by clamps and bolts, as shown by the detail in Fig. 2. Between the tops of the frames are transverse webs, through which the buffer rod passes, one coiled spring being fitted between the transverse webs, and the other between the striking head and the front web. The frames allow the pilot of an engine to pass between them, so that the pilot coupler or drawhead will engage with the striking head.

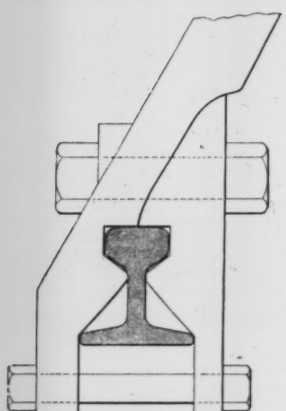


Fig. 2.—Detail of Foot of Haley Bumping Post.

The post is made in two sizes, for passenger and freight tracks, respectively, the latter being somewhat more expensive. The frames and buffer rod or plunger are of so-called semi-steel, or strong cast iron, and the springs are of steel. The post is manufactured by the King & Andrews Co., of Chicago Heights, Ill., to whom we are indebted for particulars and drawings.

STUDIES FOR A HIGH LEVEL GRAVITY SEWER FOR BOSTON AND VICINITY.

The sewage of Boston and numerous cities and towns in the vicinity is now discharged into Boston harbor at Moon Island and at Deer Island, as shown on the accompanying map. The Moon Island outlet is owned by the city of Boston, and is a part of what has been known as the Boston Main Drainage System. The South District of the Metropolitan Sewerage System at present makes use of the Moon Island outlet, and the trunk sewer leading to it. The Massachusetts legislature of 1898 instructed the Metropolitan Sewerage Commission to consider and report upon a plan for a high level gravity sewer for the Charles and Neponset River valleys. The report has just been made public. It recommends a trunk sewer with an outlet into Boston harbor, near Nut and Peddock's Islands, the estimated cost of this and some accessory work being about $4,600,000. The report discusses at some length the engineering and other problems involved. It includes some interesting figures on the actual quantities of sewage per capita from the metropolitan district in the past, and the estimated future quantities. It also contains a unique study of the effect of the sewage, from the two outlets named above, upon the waters of the harbor. The recommendations of Mr. Wm. M. Brown, Jr., M. Am. Soc. C. E., Chief Engineer of the Board, are concurred in by Mr. Jos. P. Davis, M. Am. Soc. C. E., of New York. Mr. Chas. H. Swan, M. Am. Soc. C. E., Assistant Engineer, is credited with having been in charge of the special hydraulic studies, and having been engaged in the preparation of the text of the report. The chemical studies of the effect of sewage on the waters of the harbor were made by Mr. H. W. Clark, Chemist of the Massachusetts State Board of Health.

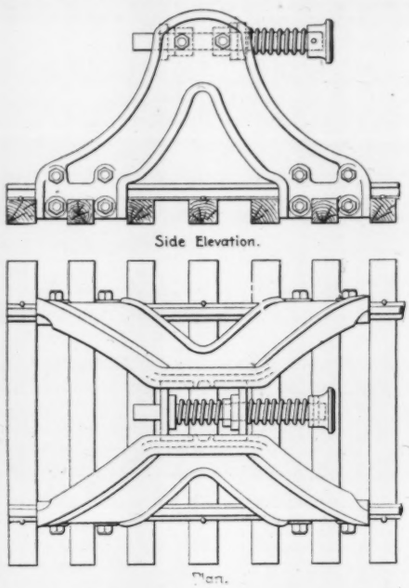


Fig. 1.—Elevation and Plan of the Haley Bumping Post.
The King & Andrews Co., Makers.

The Boston main drainage works were originally designed to serve an area of 58 sq. miles, only 12 of which, not more than 40 ft. above mean low water, was to be permanently tributary to the pumping works. For the remaining 46 miles a high level gravity sewer was to be provided later on. The 12 sq. miles named were finally increased to 15, in order to take in some higher districts pending the construction of the high level sewer. The development of the Metropolitan sewerage system, and the use of the main drainage works as an outlet for the southern district, has led to the addition of several areas, until now 121 sq miles are, or soon will be, tributary to the Boston Main Drainage, unless the plans recommended in this report are carried out, or some others substituted. What the report proposes, then, appears to be in line with the original plans for the Main Drainage, except that the territory has been doubled, and the proposed high level sewer would be controlled by the Metropolitan Board, instead of the city of Boston.

The act under which this investigation was made provides that the area tributary to the high level sewer shall be known as the South Metropolitan District. The district would embrace Waltham, Newton, Watertown, Brighton, Brookline, Dedham, Hyde Park, Milton, Quincy and a part of Boston, with an estimated population of 986,000 in 1940. The upper end of the sewer would be 8¾ × 8¾ ft. in diameter, and its lower end 11½ × 12 ft., changing to two 60-in. cast-iron pipes about 5,660 ft. long for the extreme portion. The total length of the sewer would be 81,220 ft. The outlets would be about 26 ft. below low water and 35 ft. below high water, and the flow would be continuous, as at Deer Island, and unlike the Moon Island outlet, where storage is provided for discharging sewage at ebb tide.

Maximum Daily Quantity of Sewage to be Provided for.

The capacity of the sewers is based on 300 gallons per capita per day for the population of the district in 1940, or 986,000. This gives a total of 295,800,000 gallons.

The sewage flow of 300 gallons per capita is, of course, based on the maximum hourly flow, and includes a large allowance for infiltration. The manner in which this figure was obtained is as follows:

Measurements were made in 1896-7 of the flow in the Charles River valley metropolitan sewer on 13 dates, when the flow was considered to be in a fairly average condition. The tributary area is a portion of that embraced in the proposed new district. On four dates the gagings were for 24 hours, and on 9 they were for only 10 hours, but in the latter cases estimates were made for the full 24 hours, based on the four full-day gagings. The gross population in the territory involved is estimated at 102,000 for the first four dates, and 107,245 for the others. The flow per capita per day was as follows:

Sept.	141	Apr. 2.	174	Oct. 2.	122
Dec. ...*	166	Apr. 24.*	159	Oct. 29.*	110
Jan. 11.	147	June 3.	116	Dec. 2.	146
Feb. 1.	115	June 26.	129		
Mar. 11.	190	Aug. 7.*	127	Average	142

*These gagings were for 24 hours; the others were estimated from 10-hour gagings.

The records at the pumping station of the Boston Main Drainage Works cover totals and averages for 13 years, but the per capita averages are given for two three-year periods, only. The figures are given in the accompanying table:

The Daily Average Rate of Flow per Capita at the Pumping Stations of the Boston Main Drainage.

Year.	Average yearly flow for each year. From pump records, gallons.	Estimated slip.	After deducting estimated slip, gallons.	Estimated gross population excluding Quincy.	Daily av'ge rate pr capita.
1885....	33,874,575	..	.....	.....	...
1886....	36,866,129	..	.....	.....	...
1887....	43,630,657	30%	30,500,000	274,000	111
1888....	52,937,143	30%	37,000,000	293,000	126
1889....	51,211,198	30%	35,700,000*	315,000	113
1890....	55,148,328	30%	38,600,000*	.....	...
1891....	63,749,891	30%	44,600,000*	.....	...
1892....	61,999,896	32%	42,300,000*	.....	...
1893....	72,835,209	23%	56,400,000*	.....	...
1894....	71,022,334	20%	56,400,000*	.....	...
1895....	75,625,215	18%	62,300,000*	478,446	130
1896....	81,617,509	20%	65,300,000	496,358	131
1897....	80,451,122	14%	69,200,000	514,270	134

*Estimated by the street department.

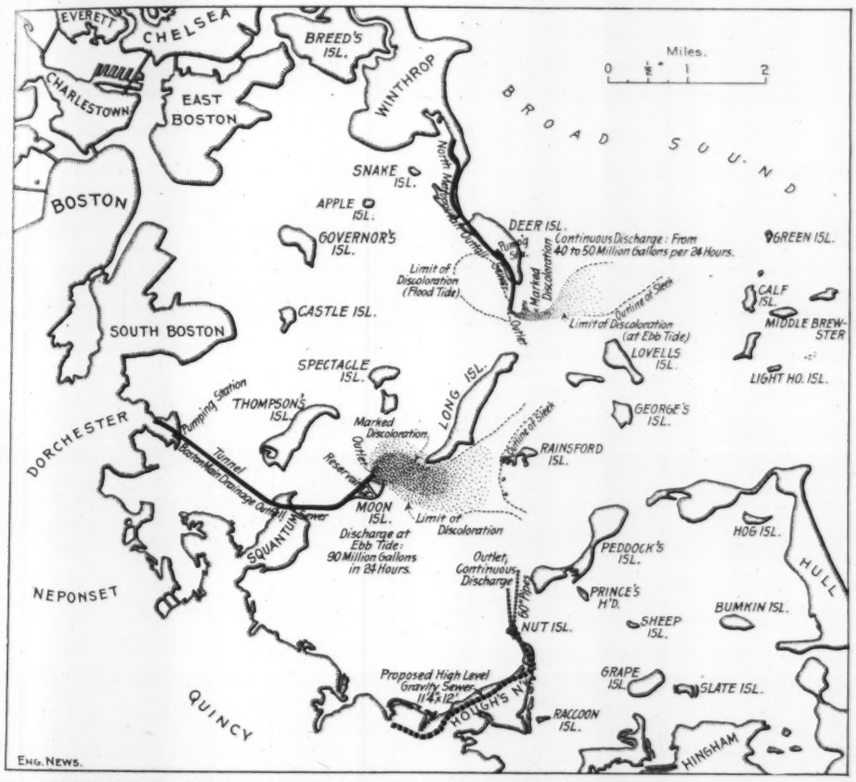
From the above figures it is assumed that the average daily per capita flow in 1900 would be 144 gallons, which is about the same as the 1896-7 average for the Charles River system. It must be remembered that the sewer in question would be an immense intercepting sewer, with storm water overflows. The aim of the study was to determine how much sanitary sewage, diluted with water of infiltration, would enter the sewer. In 1897, the maximum daily pumpage was 50% above the average. This, it will be seen, is provided for later in the discussion. For the dry weather flow it was decided to add 12% to the daily average for the year, increasing the daily flow of 1897 from 134 to 150 gallons, and of 1900 from 144 to

160 gallons per capita. This may be called the maximum dry weather flow.

Taking up next the relation between water consumption and sewage flow, it appears from the records for Boston and vicinity, and studies made by the Metropolitan Water Board, that the daily water consumption in 1900 will be 100, and in 1940 140 gallons per capita. A portion of the public water supply never reaches the sewers, but this is assumed to be offset by private water supplies. The maximum sewage flow during dry weather is about 50% more than the yearly average hourly flow, from small districts. This ratio decreases if there is any constant large flow into the sewers, as infiltration of ground water. It is also less in a long intercepting sewer, like the one proposed, because the maximum flow from the several districts does not all reach the final point of outlet at the same time. In the main sewer of the North Metropolitan system the increase is about 20% above the average hourly flow for the year. The water consumption varies by months, being at its maximum in both winter and summer weather. The winter maximum is largely due to letting faucets run to prevent freezing. This is done, mostly, at night, when the sewage flow would otherwise be at its minimum. The summer maximum is caused by waste and usage in the daytime. The summer months of greatest consumption on the Cochituate works (the main Boston supply) from 1890 to 1897 showed excesses of from 2 to 11% over the average monthly consumption for the year. The highest figure for the eight years, 11%, is very nearly the figure allowed for the monthly fluctuation of sewage at the pumping station of the Boston Main Drainage Works. Bringing together the results of the preceding discussion, we have as an estimate of the maximum daily per capita dry weather flow of sewage in 1940:

	Gallons.
Estimated yearly average water supply	140
Add 12%	17
Maximum monthly water supply	157
Deduct for leakage from water pipes	10
Maximum monthly water consumption	147
Add 20%	29
Maximum hourly water consumption	176
Leakage into sewers	24
Maximum dry weather flow of sewage	200

There remains for consideration the maximum leakage into the sewers (infiltration) during the wettest days. A study of records for five sewage pumping stations connected with the Boston and metropolitan systems indicates that 70% is a safe assumption for the mean increased flow due to infiltration in the wettest weather. Adding this percentage to the maximum hourly water consumption at the daily rate of 144 gallons for 1900 and 175 for 1940 gives 240 gallons per capita per day as the maximum storm flow in 1900 and 300 gallons in 1940. Surface water, it must be remembered, is either excluded from the sewers or, where admitted, is discharged through storm overflows when the capacity of the sewer is reached. The population to be provided for is 250,000 in 1900 and 986,000 in 1940, giving total maximum dry weather flows of 40,000,000 and 200,000,000 gallons per day, and maximum wet weather flows of 61,000,000 and 296,000,000 gallons, respectively.



AREA AFFECTED BY DISCHARGE OF SEWAGE INTO BOSTON HARBOR FROM PRESENT OUTLETS, AND LOCATION OF PROPOSED NEW OUTLET.

The Present Effect of Sewage Disposal by Dilution Upon the Waters of Boston Harbor.

Extended visual observations and chemical analyses were made under the direction of Mr. H. W. Clark, already mentioned, to determine the effect of the present sewage flow upon the waters of the harbor. By the aid of the storage reservoirs the volume of sewage discharged from Moon Island was varied on different days in order to determine the corresponding extent of the area affected by the sewage. The results obtained are summarized in the report of the chief engineer (see map, also) as follows:

The extent of the sewage tract was found to depend upon the volume of sewage discharged, the direction and force of the tidal currents and the wind. It was found that the sewage had a tendency to float upon the sea water, the latter having the greater density. The sewage was mingled with the sea water in a small area around the outlet in sufficient quantity to be detected at depths of 4 or 5 ft.; but the sewage over the greater part of the area was spread out and diluted as it moved along, and the depth at which it could plainly be detected was reduced to about 2 ft. The depth then diminished gradually towards the edges of the tract, where the sewage merely formed a film upon the surface of the water.

It follows from the preceding statement that the sewage tract was sensibly divided into three distinct areas: that nearest the outfall was small, and was much discolored; beyond this was an area of much larger extent, in which the discoloration was marked, but of much less density than in the first area; the outer portion of the tract was found to be mainly a thin film of greasy matter from the sewage, which gave to the water an oily or sleek appearance, on which account this portion of the sewage tract has been called the "sleek."

The analyses of samples taken from the sleek and from the discolored area showed that the portion of the sewage tract which contained a considerable amount of organic matter was substantially identical with the area of discoloration, and that the amount of organic matter in the sleek was so minute as not to be a source of offence. The area of discoloration, to which the temporary pollution of the sea water was mainly confined, was usually found to be broken up and dissipated in from two to three hours after the discharge of sewage, depending largely upon the force of the waves.

Such examinations of the shores and bed of the harbor as have been made indicate that no serious pollution of them has resulted from the discharge of sewage, except directly around the outlet and in the small cove near the outlet; but an appreciable pollution can be noted at low tide for some distance around both sides of Moon Island and along the causeway leading to Squantum Head.

The observations on the extent of the sewage tract as compared with the volume of sewage led to the results contained in the following table:

Volume of Sewage and Extent of Sewage Tract near Moon Island.

Date.	Volume of sewage per twenty-four hours (gallons).	Approximate area of discoloration (acres).	Velocity of wind (miles per hour).	Direction of wind.
September 14	26,000,000	226	5	S. E.
October 13	72,000,000	700	Calm	—
August 29	92,000,000	760	5	S. E.
July 1	103,000,000	770	8	N. W.

The greatly increased area affected by the larger discharges was one of the causes for concluding that the contents of the high level sewer ought not to be discharged at Moon Island, but through a separate outlet in another section of the harbor.

Observations at and near the outlet of the North Metropolitan sewer, at Deer Island (see map), similar to those already described, are thus summarized in the report of the chief engineer:

The volume of sewage discharged on the days when the observations were in progress varied from about 40,000,000 to 50,000,000 gallons per 24 hours.

The distribution of the sewage in the sea water was found to be very similar to that at Moon Island. The sewage tract was divided into three distinct areas. That nearest the outlet was strongly discolored; beyond this was a second area of larger extent, in which the discoloration was less strongly marked; and outside of all was an area in which only the sleek was found. The discoloration almost entirely disappears in one and one-quarter hours after leaving the outlet, during which time the sewage is carried about 1¼ miles, and beyond this distance on calm days the sleek only can be found. The area covered by the discolored field during the ebb tide does not usually exceed 350 acres. On calm days the area, including the sleek, may be about 450 to 500 acres.

Samples collected near the surface in the part most discolored were found to contain about 30% of sewage. This percentage diminishes rapidly as the distance from the outlet increases. The amount of sewage in samples collected at 900 ft. from the outlet was only 3%, and samples collected at the visible limit of the sewage field were found to consist of nearly normal sea water. Samples taken at the surface, at intervals of 15 minutes, following the band of sewage during the ebb tide, show a regular decrease in the percentage of sewage present, as follows: 15 minutes after leaving outlet, 20%; 30 minutes, 15%; 45 minutes, 5%; 60 minutes, 4%.

The percentage is less below the surface. Traces of sewage can be detected at a depth of 5 ft. near the outlet. This depth decreases rapidly towards the edges of the area, as is the case at Moon Island. Samples taken for analysis from the area of sleek show practically no organic matter, as the sleek itself is simply an exceedingly thin film of grease upon the surface of the water.

During the flood tide the discoloration almost entirely disappears in 1½ hours after leaving the outlet, during which time the sewage is carried about one mile. The discolored area was found to be about 300 acres. On calm days the area, including the sleek, may be about 500 acres.

The sewage discharged at Deer Island is in a much fresher condition, and consequently has less odor than that at Moon Island, which is stored in the reservoir several hours. The depth of water over the Deer Island outlet at high tide is about 9 ft. The outlet is nearly bare at low tide. The duration of slack water at high tide is about 45 minutes at this outlet.

Float observations in the vicinity of the proposed outlet for the new sewer, in conjunction with the studies of sewage diffusion at the old outlets, indicated that for many years to come sewage could be discharged from it continuously without objectionable results. The average volume of the tidal current past the proposed point of outlet is 77,000 cu. ft. per sec. at ebb and 72,000 at flood tide, the latter being about the same as at the present Moon Island outlet.

The report of Mr. Clark contains chemical analyses and a full discussion of his studies.

ANOTHER INJUNCTION AGAINST POLLUTING the Passaic River has been granted. Some months ago property-owners applied for an injunction against Newark to prevent the construction of a sewer outlet close by their property on the river front. The injunction was granted on March 11, by Vice-Chancellor Reed. In our last issue we abstracted the decision of Chancellor McGill against any increase in the quantity of sewage discharged into the river by the city of Paterson, this injunction being a temporary one, pending final hearing.

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One of the wisest acts of Governor Roosevelt since he assumed office was the appointment, on March 8, of a Commission to investigate the whole subject of the canals of the State, and the policy which the State should pursue toward them. As the members of this Commission the Governor has appointed General Francis V. Greene, M. Am. Soc. C. E., of New York; Frank S. Witherbee, M. Am. Inst. M. E., of Port Henry; ex-Mayor George E. Green, of Binghamton, and John N. Scatcherd and Major T. W. Symons, M. Am. Soc. C. E., of Buffalo.

It will be seen that the make-up of the Commission is such as to induce great confidence in the conclusions which it may reach. Its membership includes in Gen. Greene and Major Symons, engineers who stand in the front rank of their profession; Mr. Witherbee represents the large iron interests of Northern New York, and is also a business man and financier of wide reputation. Mr. Scatcherd represents Buffalo business interests, and Mr. Green the interests of the sections of the State remote from the canals which object to taxation from which they receive no benefit. The letter of Governor Roosevelt to these experts is well worth quoting, since it presents the whole situation in a nutshell:

> My Dear Sir: I am very desirous of seeing the canal policy of the state definitely formulated. As you know, the $9,000,000 designed to deepen the canals to the depth of 9 ft. has been practically expended, and it is reported that $16,000,000 additional will be needed to carry this scheme through, while at the same time certain experts have said that the scheme, when carried through, will not be satisfactory. In short, there is much conflict of opinion as to what policy should be followed with reference to the canals, and even as to the proper terminus of the canal on the lakes.
>
> I desire the opinion of a body of experts, who shall include in their number not merely high-class engineers, but men of business, and especially men who have made a study of the problems of transportation, who know the relative advantages and disadvantages of ship canals, barge canals and ordinary shallow canals, who are acquainted with the history of canal transportation as affected by the competition of railroads, and who have the knowledge that will enable us to profit by the experience of other countries in these matters.
>
> I have decided to ask five of the citizens of New York, whose reputation stands highest in these respects, to act with the Superintendent of Public Works, Colonel Partridge, and the State Engineer and Surveyor, Mr. Bond, to make the necessary investigations (and where necessary to call in the aid of special experts) to enable them to report to me at as early a day as convenient the proper course we should follow as regards this vital interest of the state of New York. I desire very much that you serve on this committee.
>
> Last year the questions which arose affecting the canals were really twofold in character—namely, those affecting the actual administration of the canals, and those affecting the general canal scheme of the state.
>
> As regards the former, the questions are now well on their way to solution. Three of the best-qualified lawyers in the state have been retained to investigate and press home any charge of corruption against any canal official which, in their judgment, can be sustained, and Colonel Partridge is so administering the office of Superintendent of Public Works as to guarantee the honest, efficient and economical management of the canals as they now are.
>
> The broad question of the proper policy which the state should pursue in canal matters remains unsolved, and I ask you to help me reach the proper solution.

We know of nothing more tenacious of life than a "fake story." As some of our readers may remember, a year or so ago the report was circulated that Russia was about to build a ship canal to connect the Baltic and the Black Seas, and it attained so much credence that the State Department finally sent out a special statement to the effect that no such enterprise was under way, or even thought of, and explaining further that any such scheme would be absolutely quixotic. Notwithstanding this official denial, accounts of this canal continue to be published, even in reputable journals, and they are so circumstantial and plausible as to entirely deceive the ordinary reader. For example, a recent issue of the St. Joseph, Mo., "Gazette," which comes to us, contains an editorial article which begins as follows:

> EUROPE'S NEW SHIP CANAL.
>
> Important as the Nicaragua Canal may be to the people of this country, it will not be of greater value than the great canal Russia is cutting from the Baltic to the Black Sea will be to the government of the Czar. This gigantic work is known as the Riga-Odessa ship canal, and is 1,080 miles in length.

The veracious author then proceeds to locate the line geographically, stating that it will follow the river Dwina, from Riga on the Baltic to Dunaberg, and will then strike across the watershed to a point on the Dnieper, "about 125 miles." The Dnieper is then followed to the Black Sea. The canal is to have a bottom width of 117 ft., a depth of 28½ ft., and "the Government insists upon it that the canal shall be so constructed that vessels may pass through at a speed of not less than six miles per hour."

We are then further told that "the entire cost of the work is estimated at $100,000,000," which reminds us forcibly of some estimates of which we have heard concerning the Nicaragua Canal. Certainly a 28½-ft. waterway, 1,080 miles long, of which 125 miles is straight digging, and the rest is slack-water navigation, would be dirt-cheap at $100,000,000. We suggest that the accomplished liar who is responsible for the above story might solve the following proportion: If it costs New York $25,000,000 to merely deepen by 2 ft. its small barge canals, 400 odd miles in extent, what will it cost to build a 28½-ft. ship canal, 1,080 miles long?

There has been a large tempest in a teapot in New York city during the past few weeks between the Manhattan Elevated R. R. Co. and various branches of the city government. It appears from the evidence of both sides that Mr. Croker's "auto-truck," compressed-air company applied to the Manhattan company for the privilege of hanging compressed air pipes along its structure to convey air at a pressure of 2,000 lbs. per sq. in., with branches running down the pillars for the convenience of truckmen desiring to replenish their supply. For this privilege they offered to pay $10,000 per annum. The Manhattan Co. declares that it refused the offer, alleging, it is stated, that the compensation was inadequate, that the structure was unsuited to such a purpose, that public opinion would condemn it, and that the company had no legal right to lease its structure for such a purpose anyway.

Soon after this the Health Board served 756 notices upon the Manhattan company, ordering them to put in drip pans at crossings, repair plumbing in stations, remove, clean and fumigate the manila matting on the car floors every 24 hours, place cinder screens upon the locomotives, stop the dripping of grease from them, etc. Following this, on Feb. 22, the Park Board adopted an order requiring the company to remove its structure from Battery Park within six months. At about the same time the Municipal Assembly adopted ordinances requiring the Manhattan Co. to place drip pans under its entire structure, and to run trains on all its lines at five minutes' headway throughout the 24 hours. At the same time other ordinances were introduced requiring the enclosing of all stations with glass, prohibiting the sale of confectionery, etc., on its stations, requiring two extra guards to each train on the front and rear platforms, and prohibiting the storing of cars on tracks built over the streets. Besides the above, inspectors of the Board of Health have rendered reports urging that the cars be equipped with vestibules, that rubber matting be used on the floors, and that extensive repairs and improvements be made upon the structure. Finally, bills have been introduced at Albany to work the forfeiture of all franchises which the Manhattan Co. holds and has not made use of.

It was curious, to say the least, that such a multitude of attacks should be made on a corporation so nearly at the same time, and in such close juxtaposition to the failure of the compressed air company's negotiations. Had all these proposed orders and restrictions been enforced, the Manhattan Co. would have been saddled with an enormous expenditure.

But the Tammany tiger, despite his threatening aspect displayed in the above, has been made to roar as gently as any sucking dove. The five-minute headway ordinance and the drip-pan ordinance, after passing the council, were rescinded, for it was discovered that the council had no authority to enforce them. The other ordinances were quietly shelved. The Health Department has modified its demands, and the railroad company is complying with such of them as have been properly made.

Did the instigators of the concerted attacks on the Manhattan Co. conclude that they had played their cards too openly to venture to push through what they had undertaken, in defiance of public opinion; or did the Manhattan authorities see and conciliate the powers that be? We give it up. Perhaps both things are true. On the whole, the late crusade against the elevated railroad company reminds one strongly of the old nursery rhyme:

> The King of France,
> With twenty thousand men,
> Marched up the hill,
> And then marched down again.

But history doesn't record whether he carried any booty down the hill.

In the last hours of the 55th Congress an amendment to the Army Appropriation bill was approved by both houses, reading as follows:

> No property, franchises or concessions of any kind whatever shall be granted by the United States, or by any military or other authority whatever, in the Island of Cuba during the occupation thereof by the United States.

The evident purpose of this amendment was to put an effectual stop to the granting of concessions by self-constituted authorities which might later be prejudicial to the best interests of the people of Cuba. Deals of this character were in full process of consummation; and one of these, favorably considered by the Autonomist Government of Cuba, would have bound that island to the guarantee of 4 per cent. on $24,465,000 for the construction of railways. There were many other deals in progress of smaller size individually, but footing up to an enormous aggregate. President McKinley recognized the danger likely to arise from such irresponsible grants, last December, and he then issued an order forbidding the granting of concessions by any Cuban authority whatever for railways, tramways, telegraph or telephone lines, water-works, gas works, electric light, etc., unless such concessions had the approval of the United States military authorities in Cuba, and that of the Secretary of War. A similar order was issued for Porto Rico, and is still in force, as the law quoted above does not apply to that island.

But the sweeping amendment adopted by Congress for Cuba seems to go a little too far in prohibiting "military or other authority whatever"

from granting concessions of any kind during the military occupation of that island. The position evidently taken by Congress is that we are the temporary guardians of Cuban interests; and that it would be improper for us to impose burdens that might be later prejudicial to, or be considered unwarranted by the Cubans when they come into full control. The measure is certainly a wise one, so far as it prevents the illegal or dishonest action of self-constituted bodies of men who represent none but themselves. But the military occupation by the United States must continue until order is fully established and the people of the island have in a measure, at least, learned how to govern themselves. Cuba, after centuries of misrule, is sadly in need of just that kind of civilization that is represented by sewerage and water-works, railways and better roads; but how will it get them under the strict enforcement of the law quoted above? The island is rich in undeveloped resources, but is poor in ready capital and in the every-day experience so essential to a due appreciation of its own sanitary and commercial requirements. To hasten the day of Cuban freedom, therefore, the impetus, capital and experience must come from outside the island; and it is here that the Act of Congress pinches. Both capital and individuals will demand a guarantee from some competent authority that the one will be secure and the other protected in all reasonable rights for a term of years sufficient to yield returns on the outlay of money and effort; and they will go to Cuba on no other terms. It may be said that no restriction is imposed upon the issue of city bonds for local improvements; but who is to guarantee the bonds; or how is the investor to be convinced that the future government, national or municipal, will not repudiate the action taken?

If the law is to be obeyed to the letter, there is but one course left for the United States; and that is to spend its own money for the future benefit of the Cubans—and for its own protection from disease and disorder in the meanwhile. This does not seem to be exactly what Congress contemplated; but it is really essential for a speedy return to conditions of permanent peace and prosperity in Cuba. All effort will doubtless be first directed towards providing a stable government for the larger cities and thus enable them to carry out their own local improvements and pay for them in bonds. But some time must elapse before even this can be done, and meanwhile the well-being of our troops and that of American officials scattered about the island demand an immediate improvement in sanitary conditions. Havana and other large cities must have sewers, and most of them must have a better water supply; railways are essential to the proper military control of the island, and better roads would aid materially in the same direction. In other words, there is much public work that must be done by some one; and if individuals, other than Cubans, are practically prohibited from investing their energy and capital in these works, the government must take them up itself. As a means of barring out all fraudulent schemes it would seem better to appoint some competent and honest advisory board, to investigate all projects and to grant concessions for those which are undeniably for the best interests of the Cubans. From present indications, quite a time must elapse before they can do this for themselves, and meanwhile the progress of Cuba is retarded and American occupation is prolonged.

PROPOSED STATE LEGISLATION TO PREVENT WATER POLLUTION.

At least five States of the Union now have before their legislatures bills designed to prevent the pollution of water. The aim of some of the bills is directed wholly to public water supplies; others include all the inland waters, without regard to their use; while a bill before the New Jersey legislature includes all "the waters of this State," which is defined as "any and all waters of any pond, lake, creek, inlet, bay, estuary, sound, river, stream, tributary, ocean or other water in or bordering this State." Connecticut, New Jersey and Pennsylvania, each have two bills before their legislatures, and Illinois and Wisconsin one each. In Connecticut and Pennsylvania the two bills are supplementary, the Connecticut plan being to vest the proposed powers in a State Sewerage Board, and the Pennsylvania plan to entrust them to the State Board of Health. In New Jersey, one bill grants slight powers to the State Board of Health, and the other creates a State Sewerage Board, with the most sweeping authority for the prevention of water pollution ever proposed to be conferred in this country or abroad, so far as we are aware. The latter act, however, must be constantly interpreted in the light of the knowledge that its real object is to provide means for cleaning up the Passaic River, and that it is merely drafted as a general act because special legislation is forbidden by the State Constitution. In Illinois and Wisconsin the duty of conserving the purity of water would be imposed upon the respective State Boards of Health.

Before considering any of these bills in detail it will be well to review briefly what other States have already done in this direction. In both Massachusetts and Ohio, all plans for new water supply or sewerage systems, and any important changes in old systems, must be submitted to the respective State Boards of Health for approval. In New York the same is true regarding sewerage systems only, but in addition the Board is empowered to make stringent and comprehensive rules for the sanitary protection of any or all public water supplies. The State of Minnesota has a very good act to protect the purity of public water supplies, which confers upon the State Board of Health the power to enforce its provisions. Other States have more or less specific statutes to prevent water pollution, but none other, so far as we know, have yet instituted efficient State supervision to protect even those waters used for public supply, to say nothing of general pollution offensive to sight or smell.

It will be noticed that the existing State supervision is entrusted to State Boards of Health, and that of the proposed bills now under discussion, those in three of the five States follow the same plan, while a fourth State, New Jersey, has one bill on this plan and another for a separate commission, and the two Connecticut bills contemplate a separate commission.

There are three strong reasons why duties of this sort should be entrusted to State Boards of Health: (1) Because the questions involved are essentially those of public health and sanitation; (2) because it is a maxim of sound government, never to create a new commission or office when the work can be done just as well by existing agencies; and (3) because of the most excellent work of this kind thus far done by the State Boards of Health of Massachusetts, New York and Ohio. That the health boards of some other States would have done good work had they been given the authority and necessary funds, we do not doubt.

Why, then, are special sewerage commissions proposed in Connecticut and New Jersey, when the duties to be entrusted to them have been so well performed by health boards elsewhere? The reasons, we assume, must be local ones, so we will leave the question for the Solons of the two States, and the promoters of the bills, to answer, merely observing in passing that as a general principle, amply sustained in practice, the sanitary supervision of the waters of a State naturally falls to its State Board of Health. There seems to be no reason, however, why a properly selected separate board, armed with the necessary authority, and with ample appropriations, should not do thoroughly efficient work. Still, we cannot refrain from asking whether the $9,000 a year in New Jersey, and $4,500 in Connecticut, which the bills appropriate for the use of special sewerage commissions, would not go further if added to the appropriations of the State Boards of Health?

Taking up the bills now before the several legislatures: One of the Connecticut bills provides for a Sewerage Commission of three or five members, appointed by the Governor, and confirmed by the Senate. The commissioners are instructed to investigate the subject of sewage disposal, with special reference to the needs of the municipalities of the State, and to report yearly to the legislature. They are to have the power to summon witnesses, with books, maps and papers. Any municipality may consult the commission

> and obtain its advice concerning sewerage systems, methods of sewage disposal, and operations relating thereto, and shall pay to said Board all expenses incurred by it in any service rendered to such town, city or borough.

Each commissioner is to receive a salary of $1,000 a year, and actual expenses not to exceed $500 a year.

The other Connecticut bill is a supplement to the first one. It provides that no municipality, private corporation or person

> shall hereafter build any sewer or sewerage system for public use in this state, or issue any bonds, or condemn any lands for such purpose, until an accurate topographical survey of the region to be sewered shall have been made, and, together with plans for effective sewage purification before discharging the effluent into any river or brook, shall have been submitted to and approved by the Board of Sewerage Commissioners.

Municipalities are prohibited from building sewers which shall discharge, directly or indirectly, any "sewage or polluted water into any of the inland streams or waters" of the State, and private corporations or individuals are prohibited from discharging (either from existing sewers or future sewers) "house sewage or excreta into any inland streams or waters" of the State.

What has preceded applies only to sewers yet to be built. The next section provides that the commission may order the owner of any existing sewer or sewerage system

> to so manage the same that the effluent therefrom shall at all times be effectively purified before it shall be discharged directly or indirectly into any public river or brook of the state, and may specify the manner and degree of such purification.

The act provides for the enforcement of this last provision by the Superior Court, on application of the commission. Violations of the other provisions of the act are made misdemeanors, punishable by fine.

The two acts outlined above seem well designed to secure the ends in view, and are to be commended for their brevity and clearness. One point covered and another omitted by the last bill may be mentioned. The sewage from all new systems must be purified before being discharged into any of the inland waters of the State, but there is an evidently studied silence regarding the pollution of tidal waters other than "public rivers." It seems, to outsiders, questionable whether the commission should not have been given discretionary powers regarding these two classes of waters, permitting, in its judgment, the discharge of limited quantities of unpurified sewage into some inland waters, and prohibiting such discharge in its discretion, into certain tidal waters.

The next State to be considered is New Jersey. While we have expressed our belief in the general principle that the sanitary care of the streams should be entrusted to State Boards of Health rather than separate commissions, there is no question as to which of the two New Jersey bills would be most effective. Broadly characterized, the bill entrusting this matter to the State Board of Health has every evidence of having suffered severe curtailment to bring it within the probabilities of passage by a legislature which for years has been deaf to nearly all appeals for stream protection. On the other hand, the bill entrusting these new duties to a sewerage commission has the aggressiveness of a measure emanating from a body which has never met defeat, and has no idea of sacrificing the ideal for a halting measure of expediency. The Health Board act is very good, so far as it goes. It provides that no sewage nor other polluting matter which will impair or tend to impair the quality of any source of public water supply, or render it injurious to health, shall be discharged into the waters in question above the intake of such supply, nor deposited on the banks of any such stream or lake, and that offenders against this prohibition shall be liable to a penalty of $100 for each offense, including each week's continuation of the offense after proper notice. This is all that could be asked, until a "provided" is reached, which excepts all municipalities (but not factories, etc.), which at the date of the passage of the act are already causing the pollution just named. The act carefully provides for legal action to enforce the above prohibition, and continues by giving the State Board of Health "the general supervision, with reference

to their purity, of all inland waters of the State used for public water supplies"; but "supervision" is not defined, nor is there any provision for enforcing any action the Board may take under this section of the act. The bill has already passed the Senate.

The Sewerage Commission bill, as already stated, is one of the most sweeping sanitary measures ever drawn. It is long and complex, but we think the following summary includes its most essential points:

It provides for three commissioners, appointed by the Governor, with the consent of the Senate, for terms of three years, at salaries of $1,500 a year each. The commission is authorized to employ a secretary, engineers, experts, clerks and workmen, and fix their salaries, but is limited in its expenditures for the first year to $5,000. The commission is authorized to establish rules to regulate and prevent the pollution of any and all the waters of the State, inland and tidal. Any person, corporation or municipality violating any of the rules of the commission is to be deemed guilty of a misdemeanor and fined $1,000 or imprisoned one year, or both. Or the commission may bring suit for both and the violator may be fined $250 for each offense, the moneys "so collected" to be used by the board for its expenses, in addition to its oppropriations. The commission may apply to the Court of Chancery for injunctions to prevent violations of its rules, and the court must hear and decide such cases on their merits.

A number of dates are fixed in the act by or before which compliance must be had with its various provisions. After May 1, 1899, it will be unlawful to build any sewer to discharge into any of the waters of the State,

> any sewage or other noxious, harmful or deleterious matter or substance, whether liquid, solid or otherwise, that will or may pollute or render impure any of said waters, or any part thereof, unless said sewage, etc., * * * shall before such discharge thereof, be subjected to such tests or treatments (or both) as such commission shall from time to tome require and approve, and subject also to such restrictions, conditions and regulations as said commission may from time to time exact and impose.

Barring the possibility that the words "pollute or render impure any of said waters" are to be given an elastic interpretation by the Commission to suit the conditions of each case, the above quotation means that after May 1, 1899, the sewage from all new sewerage systems must be purified.

The act further requires that no purification works shall be built after May 1, 1899, unless plans for the same have been approved by the Sewerage Commission; and that the operations of all such plants shall be subject to its requirements.

On or before Jan. 1, 1900, and at such other times as the Commission may require, the chief executive officer of every municipality having a sewerage system must report to the Commission, on blanks furnished by it, the mode of sewage disposal in use, the amount of sewage discharged each 24 hours, and such other information as may be requested.

July 1, 1904, is fixed as the date on and after which

> it shall be unlawful for any municipality to cause, permit or allow any sewage or other deleterious or polluting matter or substance to enter or flow or be discharged into any of the waters of this state * * * (from existing sewers.—Ed.) * * * except upon such terms and conditions and subject to such rules and regulations as said commission may impose and establish.
>
> Any person or persons, corporation, municipality or other body now discharging sewage or other noxious, harmful or deleterious matter or substance into any of the waters of this state shall, on or before a date to be fixed by said commission, which shall not be later than Jan. 1, 1903, * * * make such arrangement for otherwise disposing of said sewage, etc., * * * after July 1, 1904, as said commission shall require and approve.

The Commission must investigate all proposed plans for sewage purification, treatment or disposal which may be submitted to it under the requirement just cited, and "sanction and approve only such as in its judgment will not cause the pollution of any of the waters of this State."

Here the use of the word "pollution" occurs in such a way as to indicate that all the sewage of the State must be purified after July 1, 1904, just as that from new sewerage systems must be purified after May 1, 1899, unless the Commission may define "pollution" and "pollute" to suit itself in each case.

Altogether, this act, if backed by the courts, would make it possible to restore such of the waters of New Jersey as are now suffering from pollution to a fair degree of purity, and under it the many beautiful streams, lakes and salt pleasure waters of the State, which are still in their virgin purity, could be preserved in that condition. While the act is very stringent and sweeping, it is no more so than the importance of the subject warrants, unless it be that the Commission should be given more discretion in the matter of permitting sewage disposal by dilution where feasible, or that such discretion as is granted should be expressed in clearer terms.

Thus far we have given the provisions of only half of the New Jersey Sewerage Commission bill. The balance of it need receive little attention here. It provides in detail for the formation of sewerage districts, where it is desired that two or more municipalities construct joint systems of sewerage or sewage disposal. Such districts are to be formed largely under the supervision of the State Commission already described, and the design, construction and operation of the works would be subject to the approval of the Commission. The district boards would be elected by popular vote.

It should be noted that the Sewerage Commission bills of both New Jersey and Connecticut are the work, largely, if not wholly, of the commissions whose reports were abstracted at length in Engineering News of Feb. 16 and March 9, respectively. We are unable to state definitely the progress or prospects of either of these bills. A hearing on the New Jersey bill was set for this week, and one on the Connecticut bill for March 21.

The two bills before the Pennsylvania legislature, like all previous ones there, have met with most strenuous opposition; so strenuous, in fact, that they have been called back to committee by those having them in charge. This setback, coupled with the senatorial deadlock in Pennsylvania (only three bills have been passed up to March 13), renders the passage of any act on this subject at the present session very unlikely. Nevertheless, it will be well to see what the bills contain. Certainly no State in the Union is in greater need of protection of its water supplies. The people of Philadelphia have been dying from typhoid fever in most alarming numbers since Jan. 1, but State and local legislators alike pay little heed to such warnings.

One of the Pennsylvania acts appropriates $30,000 for a

> systematic sanitary survey and inspection of the special sources of pollution of the public streams, lakes, ponds and other waters of the State used for drinking, household and dairy purposes.

This work is to be done by the State Board of Health. The same bill was before the legislature of 1897. Properly used for the purposes named, the State of Pennsylvania could not expend money to better advantage.

The other Pennsylvania bill is entitled, "An act to Prevent the Pollution of the Water Supply of Municipalities." It authorizes the State Board of Health to examine the public water supplies of the commonwealth and determine whether they are polluted. If polluted, the cause is to be ascertained and measures taken for their abatement, "so that the water supplied * * * may be made and remain pure and wholesome." To this end notices are to be served on the persons or corporations causing the pollution to abate the same by a certain date if the pollution constitutes a common nuisance, when the State Board, preferably through a local board of health, may cause its abatement at the expense of the person committing it. If the "pollution is incidental to the conduct of some legitimate business, or connected with a municipality and does not amount to a common nuisance" the action must be by injunction proceedings in the Court of Common Pleas. The penalty for violating this act is a fine of not over $500, or three months' imprisonment, or both.

As matters are in Pennsylvania, the passage of such an act would be a great step in advance, but the procedure outlined is slow, and the bill carries no appropriation, except an authorization to use the regular appropriation of the State Board of Health, which is doubtless ridiculously small for the work the Board already has in hand.

In Wisconsin, the bill now before the legislature is identical with one that failed to pass at the last session. It is feared that it will meet with the same fate again, in which case the people will have no relief for two years from the grave dangers confronting them, there being "no law at the present time on the statute books in this State that deals with the matter." It was thought that the agitation due to the suit brought against the Ashland Water Co. for damages alleged to be due to death from typhoid fever caused by water furnished by the company, together with crusades now in progress against other polluted water supplies, would aid in securing legislation this year. The decision of the lower court, in the Ashland case, was reversed by the higher court, the latter maintaining that the company could not be held liable under the circumstances.

The Wisconsin act is founded partly on the one that has given such good results in Ohio. It is a model of brevity and clearness, like the Connecticut bills. It makes it unlawful for any municipality, corporation, public institution or person to

> introduce a new public water supply or system of sewerage in this state, unless the proposed plan of such water supply or outlet for such sewerage system shall have been examined and approved by the State Board of Health.

The sum of $1,000 is added to the yearly appropriation of the Board for the purposes of this act, and it is made the duty of the district attorney in each county to enforce its provisions. Violations render the offender liable to a fine of from $100 to $500, with imprisonment in addition, if the court sees fit.

As to Illinois, we have not yet received the proposed act. We are informed by Mr. Jacob A. Harman, Assoc. M. Am. Soc. C. E., of Peoria, that a bill similar to the Massachusetts act of 1886 was (on March 6) before the House Committee on Sanitary Affairs for consideration before introduction this week. Apparently, the bill would require the approval by the State Board of Health of the plans for all water and sewerage systems before their execution. Mr. Harman writes that the State Boards of Health of Indiana, Michigan, Wisconsin and Kansas have asked their respective legislatures for authority and appropriations to carry on the class of work under discussion, but without success. Ohio, he says, is the only State west of the Alleghenies which has yet accomplished anything of note. Dr. H. B. Baker, Secretary of the Michigan State Board of Health, confirms this statement.

An extremely valuable suggestion regarding one of the points where legislation for protecting public water supplies needs strengthening comes from the experience of Rochester, N. Y. That city has found that there are some violations of the rules laid down by the State Board of Health for the protection of the purity of its water supply which should be met with instant arrest, instead of awaiting the slow processes of the courts. A bill has been reported favorably in the New York State Assembly, which would permit immediate arrest, without warrant, in certain cases. Mr. Emil Kuichling, M. Am. Soc. C. E., Chief Engineer of the Rochester water-works, is reported by the "Post Express" as having stated that the amendment would divide acts of contamination into two classes. One would be termed "temporary" and the other "continuing" acts. The former would be further classed as misdemeanors, leading to immediate arrest, while the latter would continue to be reached by the slow processes now laid down in the statutes. An illustration of the temporary act is bathing, the person perhaps entirely escaping the law unless taken in the act.

While the progress of legislation against water pollution is lamentably slow, there are good evidences that it will be hastened in the near future. Pollution is reaching such a point in some States, notably in New Jersey and Connecticut, that it is well nigh intolerable. The Danbury and Waterbury court decisions in Connecticut, and the Paterson and Newark decisions in New Jersey, take very strong grounds against water pollution, and are bound to hasten protective legislation in these and other States. The Paterson case was reviewed in our issue of March 9. The Newark decision has been handed down since then, and prohibits the

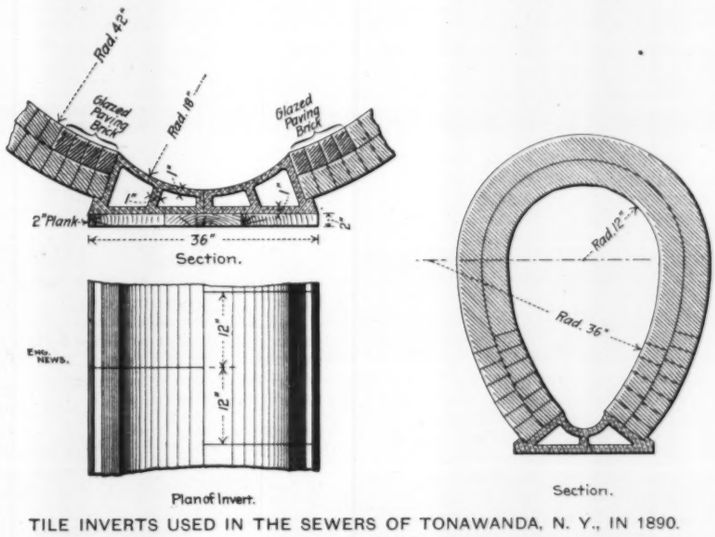
construction of an outlet sewer in Newark. The plaintiff was a manufacturer on the river front, close by the mouth of the proposed sewer outlet, who claimed that the sewer would injure his employees and his business.

In conclusion, we wish to add to the acknowledgments already made, our appreciation of the courtesies shown in furnishing the facts on which this article is based by Drs. Henry Mitchell, of Trenton, Benj. Lee, of Philadelphia, and U. O. B. Wingate, of Madison, Wis., Secretaries of the State Boards of Health of New Jersey, Pennsylvania and Wisconsin. These and the other State Boards of Health mentioned in this article, as well as the Connecticut and New Jersey Sewerage Commissions, whose reports and bills we have discussed, deserve the warm commendation of the citizens of their States and the country as a whole for the good work which they have done. Surely such faithful and earnest service in furthering a reform of such vast importance to public health and comfort, must bring eventually large results.

LETTERS TO THE EDITOR.

Sewer Invert Blocks Used at Tonawanda, N. Y., in 1890.

Sir: I note in the Engineering News for Feb. 9, 1899, a sketch of a proposed form of sewer invert taken from a paper by Prof. A. N. Talbot. In the design and construction of the sewers of Tonawanda, N. Y., in 1890, the writer used a similar form in circular and egg-shaped sewers. A lug was placed on the lower outer edge of the block to prevent the brick from slipping away from the invert. Several courses of salt glazed paving brick



TILE INVERTS USED IN THE SEWERS OF TONAWANDA, N. Y., IN 1890.
Wm. B. Landreth, Engineer.

were used for lining the sewers up to the level of the mean dry weather flow. The inverts were a success, especially in wet ground, and were used on several miles of brick sewers. The larger forms were made in two courses, owing to the difficulty of making large sizes in the sewer pipe works at that time. I enclose sketches of two forms used, drawn from memory, the plans not being at hand. Respectfully yours,

Wm. B. Landreth.

Utica, N. Y., Feb. 27, 1899.

Long Draft Tubes for Turbines.

Dear Sir: I beg to ask an answer to the following question: What is the effic ent length or limit of a draft tube below or under a water-wheel or turbine?

I always imagined that the limit was a very moderate and well-defined length, but have recently heard of a plant installed in Russia—I think—and by a Swiss firm of turbine makers, where the water-wheel is on top, and the entire "head" (or in this example it might more properly be called "fall"), which is said to be 70 ft., is utilized and developed under the turbine, by means of a draft-tube, which is constructed of concrete.

Is it safe to adopt such a scheme in ordinary or general practice? Any information you can give me on this subject will be greatly appreciated. Yours very truly,

Vera Cruz, Mexico, March 8, 1899. "Subscriber."

(The theoretical limit to the useful length of a draft-tube is set by the air pressure, and at sea level would be about 34 ft., corresponding to an air pressure of 14.7 lbs. per sq. in. Besides this the velocity of flow from the mouth of the draft-tube must be taken into account. Bodmer gives the theoretical limit of height of a turbine above the tail water level in the draft-tube as equal to

$$33.89 \text{ ft., minus } \frac{C_4^2}{2g},$$

in which C_4 is the velocity with which the water leaves the tube, and g is the acceleration due to gravity. He also states that practically the limit is made to vary with the diameter of the tube, from 10 ft. for very large tubes, up to as much as 25 ft. for very small ones. In practice, draft-tubes are generally made long enough to place the wheel well above the level of high water. There is no advantage in making them longer.—Ed.)

A "Pioneers'" Society of Civil Engineers.

Sir: I notice in your issue of Feb. 9, under the title of "A Plea for a Pioneers' Society of Civil Engineers," that some engineer, or some one who has been practicing engineering, and who signs himself "H. T.," has taken occasion to air his grievances in a very uncharitable and unprofessional manner.

H. T.'s article would seem to me to be the wail of a man who "picked up" engineering as a vocation rather than as a profession, or else, not knowing the full signification of the term engineer when he had learned to "set slope-stakes," and to do other perfunctory work by finger and thumb rules (deduced by the very class of engineers he seeks to condemn), he "hung out his shingle" with the confident hope of marching steadily on to fortune and to fame, and is only now beginning to realize that the "green man" (from college) is more highly prized by the profession for the technical knowledge gained by the burning of midnight oil over scientific literature than is the "Pioneer" for his five or twenty years of perfunctory work.

He admits that, as a rule, his class termed "Pioneers," which further on he seems to limit to include only the "anti-Am. Soc.'s," and which I will term the "non-professional," receive only foremen's wages. I will admit that the remuneration for engineering services, as a rule, is not commensurate with the labor and expense necessary to the acquirement of the theoretical and practical knowledge essential to the intelligent execution of such work, but if our brother "H. T." has had twenty years, or even ten years, of practical experience, and can now command only a foreman's salary, it is evident that he either did not have the proper foundation to build upon, or he has sadly neglected his opportunities. In either case the term "non-professional engineer" fits him pretty well and he is now beginning to realize that all along he has been "barking up the wrong tree."

"H. T." has probably taught college men to "set slope-stakes," and perhaps to compute earthwork by the prismoidal formula, but can he deduce this formula? He can use the table of sines and cosines, the table of logarithms, and perhaps many others, but can he compile these tables, and does he have a clear conception of their significance and use? Possibly he can compute the stress in strained members by use of formulas ready provided, but can he verify these formulas; can he compute the "radius of gyration" or the "moment of inertia" of these members? If he can do none of these things, all of which are essential to a clear conception of his duties, then what right has he to dub himself an engineer and set up a howl because that most worthy and honorable body, the American Society of Civil Engineers, fails to recognize him as such?

There have been, and are yet, many able and reputable engineers who never had the advantages of a thorough course in the technicalities of their profession, but they are the exception and not the rule, and by such it is always lamented. Practical experience in engineering is very much to be desired, but an educated "green man" can learn more from the experience of one year in the field than the self-styled engineer can in five. Then why should a man who has had five years in the field and none in college have precedence over one who has had four years in college and one in the field? Mr. "H. T.," I fail to see the force of your argument.

If I have misjudged our friend I shall be very sorry, but I very much fear that in the selection of his vocation "H. T." was in need of the advice given a young candidate for the ministry, in the pioneer days of Methodism, by a more elderly follower of the humble Nazarene. The young candidate upon being called upon for evidence that he was called to preach the gospel related that on a certain night, while engaged in earnest prayer under the canopy of a midnight heaven, for a sign whereby he might know his calling, he saw in the heavens, clear and distinct, the letters "G. P. C." This he construed to mean, "Go Preach Christ." The elderly gentleman arose and said, "My dear young brother, the step you are about to take is a grave and sacred one, and lest you may have misconstrued the sign you saw I will remind you that it might have meant 'Go Plow Cotton.'" So, too, I am afraid that the letters "G. P. E." seen by our friend on the horizon of his youthful ambition some twenty years ago and which he construed "Go Practice Engineering" might have meant "Go Pick Earth." Yours truly, "X."

March 6, 1899.

Cylinder Ratios for Compound Engines.

Sir: The discussion of the above subject in Engineering News of March 2 is an interesting contribution to steam engineering literature. It is particularly interesting to me, because it strengthens the position taken by a few of our engineers in regard to terminal drop in the high-pressure cylinder of compound engines. The published transactions of the American Society of Mechanical Engineers contain several papers on this subject with considerable discussion, in which the theory that the best economy is obtained with terminal drop in the high pressure cylinder has been vigorously assailed by nearly all of those who participated in the discussion. I have for a long time been convinced that large cylinder ratios and consequent terminal drop in the high-pressure cylinder is necessary to the best economy. It has seemed to me that the matter is perfectly demonstrated by the well-established facts regarding simple engines. I have always claimed that each cylinder of a compound engine may be considered as a simple engine, receiving steam at a certain pressure and discharging it at a lower pressure, and that each cylinder must develop the highest attainable economy for a single cylinder operating between the given pressures. If this is true, then we can refer to tests of simple engines for information, and we all know that it is never economical in a simple engine to carry the expansion down to the line of back pressure, and that the best economy in every recorded test is obtained with an appreciable terminal drop. The reason for this is apparent and is due to the fact that cylinder condensation is so nearly a constant amount at every point of cut-off, that with larger loads it becomes a smaller percentage of the total steam used, the difference being so great that a certain amount of useful work may be thrown away at the end of the stroke for the sake of the great gain in the percentage of cylinder condensation.

Mr. Rockwood's work has been a very practical demonstration of the correctness of this theory. The accuracy of his earlier tests was no doubt questioned by many of our engineers, but they have been so often repeated and by disinterested experts, that there is no longer any room for doubt as to the accuracy of the figures obtained. I have never quite agreed with Mr. Rockwood that the triple-expansion engine is no more economical than these compound engines of large cylinder ratios, and have always contended that no such conclusion could be reached without comparing his engine with a triple-expansion engine built on the same plan, and in which each cylinder should have a proportionate amount of drop and the total number of expansions should be very much larger than has been obtained in any of the engines used for comparison. It must be very apparent to anybody who investigates the subject of loss of work by terminal drop that it is the low-pressure cylinder where the great.st loss occurs. This matter is presented fully in the published transactions of the American Society of Mechanical Engineers, beginning on page 759 of volume 15. In this paper referred to it is shown that the loss of work occasioned

by a terminal drop of 4 lbs. in the low-pressure cylinder of a triple-expansion engine is equal to the loss of work occasioned by a terminal drop of 40 lbs. in the high pressure cylinder. The actual difference between the two, however, is vastly greater than these figures would represent, because the reheating effect of terminal drop in the high-pressure cylinder improves the quality of the steam entering the next cylinder so very much that the apparent loss is largely offset by this considerable gain; whereas, with the low-pressure cylinder, any improvement in the quality of the steam discharged from this cylinder produces no saving and is entirely wasted. The conclusion, therefore, seems to be inevitable that a very considerable terminal drop in all the cylinders but the low-pressure is desirable, and that in the low-pressure cylinder the drop must be reduced to a minimum if the best economy is to be obtained. One of the unaccountable things in connection with this subject is the apparent indifference that engineers feel regarding terminal drop in the low-pressure cylinder, and at the same time they object to any drop whatever in the high-pressure cylinder. A discussion of this subject will be found in volume 16 of the transactions of the American Society of Mechanical Engineers, beginning on page 184.

It is to be hoped that at no very distant day somebody may build a test engine with an assortment of cylinders sufficient to make it possible to conduct a series of tests in which all the conditions may remain constant except those which are sought to be investigated. Such a test would be a very important step in the development of compound engines.

F. H. Ball.

Bound Brook, N. J., March 13, 1899.

Regenerating Exhaust Steam.

Sir: Your valuable comment on the methods of the United States Patent Office in the article on "Exhaust Steam Regenerating" is very timely. I also received a circular and a proposal to erect a regenerator in our plant. Like yourself, I could not get over the dangerous novelty of the proposition that economy could be possible with back pressure. I don't like your comparison of Mr. Barron to Watt and Newcomen. Those great men were real engineers, while I should understand that Mr. Barron was in the tinning and heating business. I cannot see that the anticipation of a worthless invention is really of any interest; what interests me is that the engineers of the patent office do not understand the scientific principles that underlie steam engine economy, viz., that to utilize the energy of steam or heat we must have the greatest range or difference of temperature between which the elastic body is worked. If we could do (what is, of course, impossible), expand down to absolute zero from any fixed temperature we would get the greatest economy. We cannot do this, but we do the next best possible thing, work between the greatest extremes of pressure. I would say that most students of thermodynamics know that the steam engine to-day is almost a perfect thermodynamic machine. The only improvement possible is in the direction of refrigerating, not regenerating. Mr. Barron should have saved his money and taken a course in engineering at one of our first-class schools.

Very respectfully yours,

A. S. Uperkaught, C. E.

432 W. 34th St., New York city, March 9, 1899.

Sir: My attention has been called to an article in the issue of March 2 of your publication, entitled " 'Regenerating' Exhaust Steam," and upon reading the same I feel compelled, in view of some of the statements contained therein, to take up my pen to answer the same. At the very outset, however, I would state that it is not my intention to take issue with the writer in regard to the points he raises touching the merits of the invention. The attacks seemingly directed from so many different sides would lead a disinterested person at once to doubt the sincerity of his motives, and the impartiality of his investigation, and I would not think of devoting a moment of my time to the matter, nor request you to do so, were it not for the closing paragraphs of the article, and the underlying sarcasm and insinuation therein.

As a lawyer who regards the patent practice as the most dignified branch of an honored profession, and as an admirer of the American Patent System, the Patent Office and its employees, I do not feel that the matter can be permitted to pass without comment; and, further, as I happen to be the attorney for the inventor, and having been approached by persons interested in steam engineering, and fellow-practitioners under whose notice this patent has come, and my name having thus become identified therewith, and known to some of your readers, I feel that these paragraphs in question do me a grave injustice, and at the same time constitute a reflection upon the character and integrity of the Patent Office Examiner, who, for reasons of public policy and propriety, cannot answer the same in his official capacity.

I trust, therefore, you will not hesitate to grant me a small space in your valuable publication.

It is well known that the Patent Office practice is so beset and hemmed in by technicalities and details that the layman, and even the experienced inventor, is frequently unable to comprehend the whys and wherefores of the actions of the Patent Office, his attorney, and, sometimes of both, and knowing this I am astonished to find that a technical publication enjoying so high a standing as yours does in the engineering world will take a technical communication, and a technical argument written in answer thereto; abstract the latter and publish the same with comments without first explaining to the uninformed reader the true nature and significance of the said communication and argument, and then, by insinuation and innuendo, lead the uninformed reader to believe that "more substantial arguments" were employed in addition to the written one, and that these latter must have been the potent factors in bringing the application to a favorable conclusion.

In explanation of the conciseness of the argument quoted, I would state that I do not, as a rule, believe in efficacy of prolix arguments in the ordinary prosecution of an application, in view of the congested state of business in the Patent Office, and in the particular case in question, I might have, in view of the amendment, attained the same result without the argument, and would have dispensed entirely therewith were it not that it facilitates the prosecution of an application if the attorney for an applicant makes known to the Examiner that he (the attorney) understands his end of the case, and also that he understands the position the Examiner takes in the matter, and for this purpose the argument was sufficient.

Before concluding, I would venture the opinion that were the writer of the article in question sufficiently versed in Patent Office practice to differentiate an action by the Patent Office involving the merits of an invention itself from one which, while tacitly conceding the merits of the invention, involves the same only as set forth or defined by the terms of the claims, I feel certain he would not have fallen into the trap and indulged in the objectionable language.

I therefore trust you will, in the interests of justice and fair play to the Examiner, whom I do not know personally, but for whose ability, uniform courtesy and the businesslike methods in the discharge of his official duties I, and all who have come before him, entertain the highest respect and admiration, and in justice to the undersigned, who does not wish to be placed before the public in a false light, you will give this letter as conspicuous a place in your publication as you did the article referred to above.

Very respectfully yours,

C. Augustus Dieterich.

229 Broadway, New York city, March 9, 1899.

(We have carefully examined our article to which Mr. Dieterich takes exception, and are unable to find anywhere in it the slightest "insinuation or innuendo," or the faintest hint concerning the use of "more substantial arguments" by the inventor's attorney to cause the allowance of the application by the patent office. Certainly no such idea ever entered the minds of the editors who prepared the article. The criticism in our former article was directed at the patent office for issuing a patent upon an invention which was contrary to established scientific facts. We are inclined to believe, however, that the attorney who prosecutes such an application is more deserving of criticism than the patent office officials. Was Mr. Dieterich so ignorant of elementary principles in steam engineering as to fail to detect the mechanical absurdity in Mr. Barron's alleged invention; or did he, on the other hand, prosecute the application with the full knowledge that it was contrary to established scientific facts? We should think either horn of the dilemma would be a very uncomfortable one.—Ed.)

Notes and Queries.

A. D. R., Boston, Mass., asks whether any large chimneys for factories or other purposes have been built in this country of concrete.

We know of none. If any of our readers can give information as to any such construction, we shall be pleased to hear from them.

Mr. Frank Schefold, of New Albany, Ind., referring to fire losses caused by frozen hydrants, inquires why salt is not used to prevent freezing. He states that with 175 hydrants in charge for ten years past he has never had one freeze. Where he can do so, he pumps the water from the hydrants; where he cannot pump them out he places a half gallon of salt in the hydrant (case ?) for the winter, washing it out in the spring.

ASTERIONELLA AND ITS EFFECT UPON PUBLIC WATER SUPPLIES.

A paper on the above subject was read before the New England Water-Works Association on March 8 by Mr. Geo. C. Whipple, Biologist and Director of the Mt. Prospect Laboratory, Brooklyn, N. Y., and Mr. D. D. Jackson, Chemist. The full paper will be published in the Journal of the Association. The following is a summary of the paper:

In this paper we have endeavored to establish the following facts:

(1) That the common form of Asterionella is that known as A. formosa var. gracillima, but that great variations exist in size, shape, and arrangement of the cells.

(2) That Asterionella is widely distributed in nature, and that it is found chiefly in lakes, ponds and reservoirs, where comparatively clear water is stored.

(3) That its growth in surface waters occurs chiefly in the spring and fall, and is intimately connected with the phenomena of stagnation.

(4) That it develops most vigorously in open reservoirs where ground water is stored, and that its growth in these reservoirs follows the same laws as in surface waters.

(5) That its odor varies in character from geranium to fishy, and that under favorable conditions 3,000 Asterionella per cu. cm. may impart to water an odor that will be easily recognized by the consumers.

(6) That it forms spores during periods of rest, and that sporulation takes place at the bottom of reservoirs during periods of stagnation.

(7) That its sudden developments after such stagnation periods are due to the germination of these spores.

(8) That its food supply is a definite quantity and that the organism will not grow in a water where any one of its constituents cannot be obtained in sufficient quantity and in a form capable of assimilation.

(9) That the food elements most likely to be deficient in water are silica, manganese, iron and nitrates.

(10) That if reservoirs are not kept clean stagnation tends to increase the amount of food material in the water, and that the increased amount of food material after the stagnation periods helps to explain its periodic seasonal occurrence.

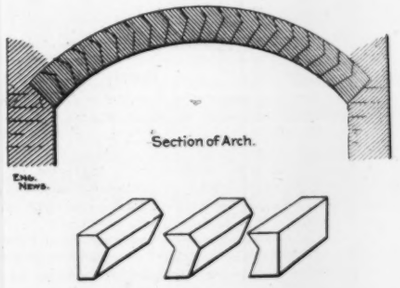
(11) That, while it is desirable that ground water should be stored in the dark, it is possible to alleviate the troubles due to the growth of Asterionella in open reservoirs by keeping such reservoirs free from deposits at the bottom, thus preventing them from becoming seeded with spores and also preventing a material increase in the food supply.

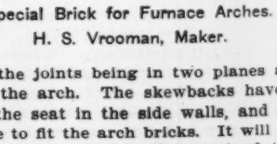
(12) That where open reservoirs must be used for the storage of ground water, they should be so designed that they may be cleaned whenever necessary, and that they may be isolated from the system whenever growths of organisms make the water unsuited for use.

An account of an occurrence of asterionella in the Brooklyn water supply during 1896 was given in Engineering News for July 1, 1897, having been abstracted from a report by Prof. A. R. Leeds, of the Stevens Institute of Technology, Hoboken, N. J. Professor Leeds was assisted by Mr. Whipple in making the investigations recorded in the report.

SPECIAL BRICK FOR FURNACE ARCHES.

A new form of fireclay brick for furnace arches and roofs is now being introduced, the main objects of which are to enable a flatter roof to be built, and to prevent the dropping out of bricks due to the expansion or contraction resulting from sudden changes of temperature. They are larger than ordinary bricks, and their peculiar form, as shown in the accompanying cut, is such as to cause them to dovetail or lock together when





Voussoir and Skewback Bricks.

Special Brick for Furnace Arches.
H. S. Vrooman, Maker.

in place, the joints being in two planes and not radial to the arch. The skewbacks have a flat base for the seat in the side walls, and a dovetailed face to fit the arch bricks. It will be seen that a very extensive displacement of the side walls would be necessary before a brick could drop out of the arch.

These bricks are said to be especially adapted for furnaces for treating malleable iron, as they will stand longer in the "bung" or cover of the furnace, and will not drop out when the bung is lifted off.

The bricks are manufactured by the patentee, Mr. H. S. Vrooman, 220 W. 20th St., Chicago, Ill.

THE SEMET-SOLVAY BY-PRODUCT COKE-OVEN PLANT AT ENSLEY, ALABAMA.*

By William Hutton Blauvelt, M. Am. Inst. M. E.†

An official of one of the prominent iron companies of the South recently made the following statement during a discussion of the present conditions of the Southern iron business:

The trouble with us in the South has been that we have been satisfied to buy iron and coal lands, build blast-furnaces, and make pig-iron. We stopped at pig-iron, and as a result we are all poor. The South needs diversified industries, and needs to work up its raw products into articles the Southern market can use. If we had realized this sooner some of us might now be rich.

The South is awakening to this view, and in the Birmingham district alone one basic steel-mill is already in operation, and in a year's time another and much larger one will be turning out rails and shapes, with rod and wire-mills in prospect.

It is to chronicle another metallurgical step forward in the same district that I have prepared the following description of the new by-product retort coke-oven plant recently put in operation at the Ensley, Alabama, furnaces of the Tennessee Coal, Iron & Railroad Co. It may, perhaps, be well, before describing in detail this particular plant and the availability of its products for the markets of the South, to discuss the by-product oven in general and compare its operation with that of the beehive oven, as many of our members know only the latter, and the difference between the two is very wide, both in construction and in method of operation.

The by-product retort-oven was invented and developed on the continent of Europe, and was specially successful on account of the excellent results it obtained from the lean coals prevalent there, that were coked with difficulty, or not at all, in the beehive oven. In Europe the retort-oven is used both with and without the saving of the by-products, although most of the recent plants include by-product apparatus.

The retort-oven differs from the beehive in shape, in principle of operation, and in results. As most of us know, the beehive oven is dome-shaped, about 12 ft. in diameter, and 6 to 7 ft. high in the center. The coal is charged through a hole in the center of the roof, and is leveled off in an even layer about 23 ins. deep. The fresh charge is fired by the heat remaining in the walls from the previous charge, and the combustion is supported by air admitted through the front door, over the top of the charge. The volatile matter in the coal is driven off by the heat and burned in the top of the oven, along with a portion of the fixed carbon. The source of heat being at the top, the coking extends from above downward, with the formation of long finger-like pieces. The coke is quenched before it is drawn from the oven, thereby preserving the carbon glaze that has been thought so important in the blast-furnace. Thus the process of coking in the beehive oven is affected by the partial combustion of the charge itself.

The retort-oven is a long narrow chamber, from 30 to 33 ft. long, about 6 ft. high, and from 15 to 20 ins. wide, depending on the quality of the coal that is to be coked. The charge is introduced through several openings in the top, and nearly fills the chamber, which is sealed tightly as soon as the surface of the coal is leveled. The ovens are built in blocks of from 25 to 34, and between each two ovens flues are arranged, in which gas is burned to supply the heat for coking the charge within the ovens.

This gas is a portion of what is driven off from the coal, and by its combustion with hot air a high temperature is readily maintained in the flues. The heat passes through the thin walls of the flues into the coal, which undergoes a true distillation, the volatile matter passing off without coming in contact with any air; consequently no combustion takes place. There is, however, a little breaking down of the hydrocarbons by the action of the heat, and a deposition of carbon that causes the retort-oven to yield a higher percentage of coke than the theoretical, while the beehive oven yields less than the theoretical, owing to the partial combustion of the fixed carbon that takes place.

As the supply of heat in the retort-oven comes from the sides, the flow of the gases generated is from the sides toward the center, while the free expansion of the coke is somewhat checked. As a result, some coals that in a beehive oven make a coke that is too soft and spongy for blast-furnace use, are hardened and strengthened in the retort-oven, and are able to bear the furnace burden. Owing to the narrow oven and the different application of the heat, the time necessary to coke a charge is much less in the retort than in the beehive oven, the time varying with the coal and the type of retort-oven from 18 to 36 hours for the former, instead of the usual 48 and 72 hours of the latter.

When the charge in the retort-oven is coked, doors at each end are opened and the charge is pushed out by a steam-ram, and quenched as it leaves the oven. As soon as the ram is withdrawn the doors are closed, and the oven is ready for charging, with practically no loss of heat. The whole operation of discharging and charging an oven can readily be completed in 15 minutes.

By proper attention to the quenching, it is not difficult to keep the moisture in retort-coke as low as in beehive coke. Its cellular structure causes coke to absorb moisture with great readiness when cold, and a few days' exposure to the air in damp weather will often cause a gain of 10% of moisture, or even more. It may be well to note here, however, that the usual laboratory methods for the determination of moisture in coke are quite inaccurate, and the results correspondingly unreliable. Beehive coke can be produced with less moisture than the most carefully prepared retort-oven coke, for it may for purposes of experiment be left to steam in the oven after quenching until practically dry; but after a few days' exposure to the air, it would not differ in moisture from properly quenched retort-coke.

In the retort-oven without apparatus for saving the by-products, the gases distilled from the coal pass directly into the flues at the sides of the oven, where they are burned, the heat in excess of what is required for coking being used for raising steam. In the by-product plants the gases leave the oven through an opening in the top and enter a collecting-main running along above the ovens. This is usually constructed on the principle of the hydraulic main of the illuminating gas works. The gas bubbles through water in this main, and part of the tar and ammonia are condensed out as the gas is partially cooled, and are collected and saved.

From this hydraulic main the gas is led to tubular condensers, where it is cooled as thoroughly as possible by contact with a series of tubes through which cold water is flowing. By this second reduction of temperature more tar and ammonia liquor are separated. Then the gas goes to an exhauster, which delivers it to a final scrubbing-apparatus, to remove the last traces of tar and ammonia. A portion of the gas, thus cooled and purified, is returned to the flues of the ovens, where it is burned, and the remainder, rather less than half, is available for various purposes.

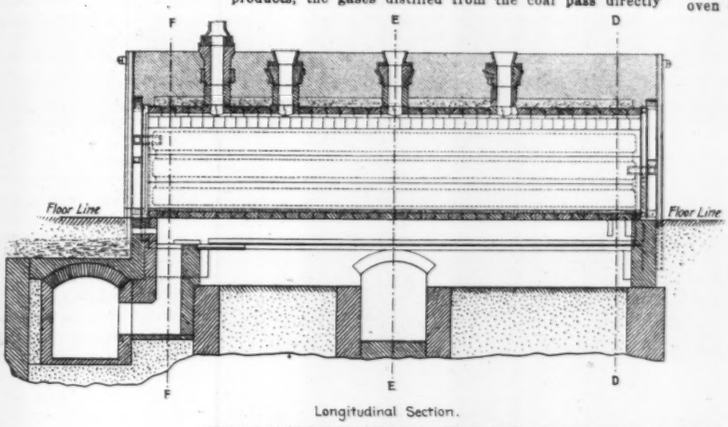
The tar collected from the several operations is pumped into tank-cars ready for shipment, while the ammonia is concentrated into strong crude ammonia liquor, or made into sulphate of ammonia. The amount of by-products obtained depends greatly on the quality of the coal. A short ton of coal will yield from 15 to 25 lbs. of sulphate of ammonia, and from 5 to 14 gallons of tar. The amount of gas produced also varies from the same cause, but it is usually from 8,000 to 11,000 cu. ft. per ton of coal. 5,000 or 6,000 ft. are needed to supply the necessary heat to the ovens, the waste heat from which furnishes just about enough steam to operate the plant.

The remainder of the gas is available for any purposes for which natural gas can be used, although it is not so rich. It ordinarily contains from 600 to 700 B. T. U. per cu. ft., while natural gas has about 1,000. As ordinarily made, the coke-oven gas is of too low candle-power to permit its use for illuminating purposes, as it averages from 10 to 12 candles; but by taking advantage of the well-known fact that in the distillation of coals, the bulk of the illuminants and hydrocarbons come off in the first part of the operation and the hydrocarbon * * * and carbonic oxide afterward, the distillation can be divided into two parts, a gas of from 16 to 19 candle-power being produced and sold for illuminating purposes, and the poorer gas being used for firing the ovens. A plant of ovens is now in operation which is furnishing without enrichment the whole amount of illuminating gas used in a city of some 40,000 inhabitants.

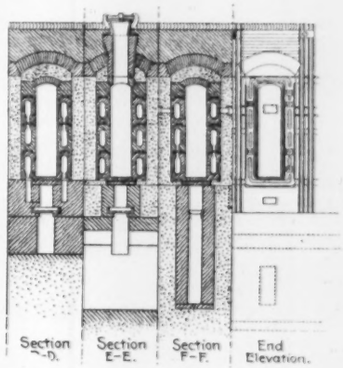
While the principles of operation are the same, there are two distinct types of retort-ovens, viz., the vertical and horizontal-flue types. In the former there are some thirty-odd vertical flues in each wall between the ovens. These are connected at the top and bottom by larger horizontal flues running the length of the oven, the lower one being divided into two parts by a partition midway between the ends. The gas is burned in the lower flue, the flame rising through half the vertical flues and descending through the other half and escaping usually to regenerators of the ordinary reversing type, which heat the air for the combustion. The course of the gases is reversed about every hour and sent through the flues in the opposite direction.

In the horizontal-flue oven the gas is burned in horizontal flues, usually three in number, which are connected at the ends so as to form a continuous system, the gas being admitted through small pipes at the ends of the top and middle flues, where it meets the air for the combustion. The gases travel from above downward, pass under the bottom of the oven, through a simple recuperative arrangement for heating the air, and then to boilers where steam is made for operating the plant.

The ovens at the Ensley plant are of the Semet-Solvay horizontal-flue type, illustrated in Figs. 1 and 2. In this oven the designers have developed the principle that the flue-walls should be thin, to permit the ready passage of the heat to the coal, and that the weight of the top of the oven, which is necessarily thick and heavy to retain the heat, should be removed from the thin, almost white-hot flue-walls, and carried independently.



Longitudinal Section.



THE SEMET-SOLVAY BY-PRODUCT COKE OVEN, AS ERECTED AT ENSLEY, ALA.

A solid fire-brick wall, 18 ins. thick, is therefore placed between each two ovens to carry the load of the roof, coal-cars, tracks and whatever may be placed upon it. Each oven, therefore, has its separate set of flues, which may be entirely removed if necessary without affecting the general structure; and, carrying no load, they are free to expand and contract with the changes of temperature incident to the introduction of the cold charge and its heating up to the point necessary to complete the coking process. Moreover, the thick brick walls form a reservoir of heat that is of considerable assistance in keeping the temperature of the oven uniform. Thus the design of the oven is such as to give a maximum life to the flues (which are the only part of the oven that can wear out), while at the same time it admits their ready repair, should it be necessary, without affecting any other ovens in the block.

The plan of introducing the gas in several places and at the ends of the horizontal flues gives perfect control over the heats in each flue, and permits their examination at any time to see that the proper temperatures are maintained. This arrangement insures that each flue shall have just the temperature best suited to the work to be performed, and prevents one part of the oven being overheated while another is too cool.

The plant of Semet-Solvay ovens at Ensley consists of 120 ovens, arranged in two parallel blocks of 60 each. The coal used is the washed slack from the Pratt seam, and it is expected that the plant when in full run will produce from 420 to 460 tons of coke per day. This coke will be consumed by the Ensley furnaces.

In the design of the plant careful attention has been given to the problem of handling materials with a minimum of labor, and at the same time elaborate handling machinery has been avoided as being unsuited to the class of labor most available.

A spur from the track leading from the Pratt coal mines and washers is carried directly over the coal-bins above the ovens, the track having a grade at the steepest part of 1.65 ft. per hundred, so that a locomotive can de-

*A paper read at the Buffalo meeting of the American Institute of Mining Engineers.

†Engineer the Solvay Process Co., Syracuse, New York.

liver a day's supply of coal at one shift. The coal is delivered in 30-ton cars with sloping hopper-bottoms, and one laborer can easily dump in ten hours the whole day's supply. The bins have a capacity of 1,500 tons of coal, to provide against any irregularity in the supply. The coal for charging the ovens is drawn into larries below the bins and charged into the ovens as above described.

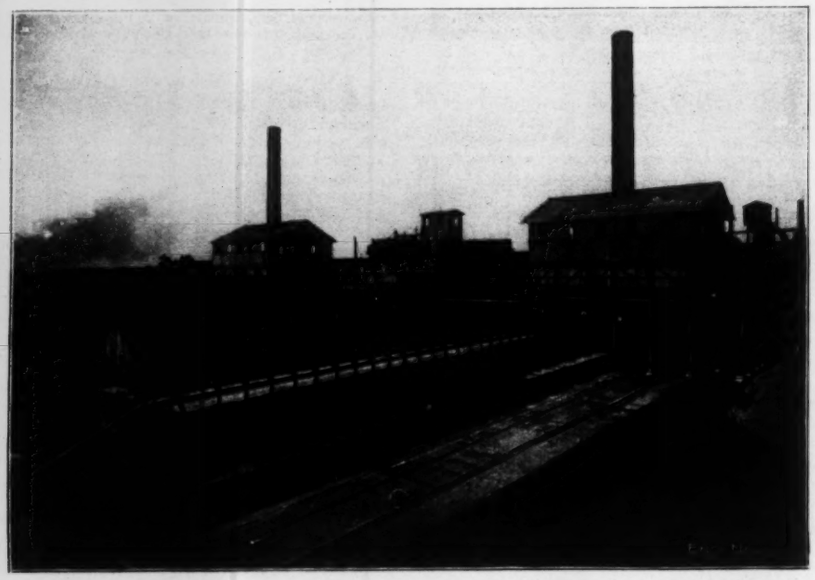
When coked the charge is pushed from the oven by a steam ram and quenched as it falls onto a car provided for the purpose. This car is 30 ft. long and 7 ft. wide, with a sloping bottom, and is so arranged that when pushed out on it, the coke lies in a thin even layer that permits complete quenching with a minimum resultant moisture in the coke.

The blocks of ovens are located at right angles to the line of the Ensley furnaces and about 350 ft. distant from the stock-house. This arrangement permits the most convenient delivery of the coke to the stock-house. By a wire rope and winding-engine the quenching cars are drawn up a grade of one to six into the stock-house to an elevation sufficient to permit the coke to be dumped into a large bin with a sloping bottom, which in turn discharges directly into the furnace-buggies that are sent to the tunnel-head. Thus the coke is moved but three times after it is quenched until it lies in the furnace, and the breakage is reduced to a minimum. A coke-fork becomes a useless utensil, with a corresponding reduction of labor.

Turning now to the by-product from the coking plant, within a short distance of the oven-plant. This gas will doubtless prove to be of more value as an auxiliary than as a direct substitute for producer-gas in the open-hearth furnaces. It will be a great convenience for drying ladles, heating soaking-pits, or in other places where comparatively small quantities of gas are required, and of a better quality than ordinary producer-gas. It has been suggested that the open-hearth furnaces be piped for the coke-oven gas, in order to provide an easy means for rapidly controlling the heats, if the occasion should arise.

While the oven-plant is not yet in full run, yet enough work has been done to make a reliable comparison between the production of coke from this plant and from the beehive ovens of the Birmingham district. It is the practice of some of these plants to coke two 48-hour charges and one 72-hour charge per oven per week. At other places it is more common to run one 72 and one 96-hour charge per week. A comparison of the output of the by-product ovens and the beehive shows that the 120 ovens in the by-product plant will equal in production about 300 beehives making 48 and 72-hour coke, and about 340 beehives running on 72 and 96-hour charges. The charges of coal are heavier when the beehives make only two charges per week.

This difference in the output per oven of the beehive and retort-oven plants is due to the more rapid coking in the retort-oven, although the individual charges are smaller, and also to the increased yield in coke per ton of coal due to the improved method of coking. Tests have shown that



GENERAL VIEW OF SEMET-SOLVAY BY-PRODUCT COKE OVENS, AT ENSLEY, ALA.

the by-product building is located midway between the two blocks of ovens and is of slow-burning mill-construction. Two sets of gas condensers, one for each 30 ovens, are at each end of the building, and beyond them at one end is the sulphate of ammonia house. Within the building are the necessary exhausters, washers, pumps, tanks, etc., for collecting the by-products. Immediately adjoining the property on the west is a tar-distilling plant, and the tar collected from the gas, after being measured, is pumped directly from the by-product building to its receiving tanks. This plant produces from the tar, roofing-pitch, tar-paper and creosoting oils, for all of which products there is a market in the South.

The ammonia produced is at present manufactured into sulphate of ammonia. As the ammonia is condensed out of the gas it is collected in the form of a weak liquor containing probably not more than 1% of NH_3, along with a good many impurities. To make the sulphate this liquor is distilled with steam and the resulting ammonia gas is absorbed in a bath of sulphuric acid contained in a lead-lined tank. The crystals of sulphate fall to the bottom, whence they are raked out, drained and bagged for shipment.

The sulphate of ammonia finds a ready market, as there are large fertilizer-factories in a number of the Southern States, and sulphate is one of the most valuable sources of nitrogen obtainable. It is worth more per unit of nitrogen than nitrate, blood, or any of the other usual sources of this important element. Anhydrous ammonia, that is, ammonia gas condensed by compression into the liquid form, is used in large quantities throughout the South in the manufacture of artificial ice. This form of ammonia is not produced in the Ensley plant as yet, but it may be arranged for later.

The surplus gas from the plant, of which there will be some 2,000,000 cu. ft. or more per day, is to be used in the new basic open-hearth steel-mill that is being erected this increased yield adds from one-sixth to one-fifth to the amount of coke produced from a ton of Pratt coal.

An estimate of the labor on a beehive plant of 300 ovens compared with that on the plant of 120 by-product ovens as operated at Ensley shows that the latter requires about 15% more hours labor per day than the former. For the beehive plant are included only the men required to charge, level, water and draw the ovens and to load the coke onto cars. For the by-product ovens are included all men required about the plant, except the foremen, including those on the ovens and in the by-product plant, delivering the coke into the furnace stock-house, loading the sulphate of ammonia into cars and delivering the tar to the purchaser. The delivery of the coke is a question of location. If the ovens were not at the furnace-plant the coke would be delivered into railroad-cars.

PUBLIC BATHS AND GYMNASIA IN BOSTON.

Some interesting facts regarding public baths and gymnasia in Boston were given a few days ago by Hon. Josiah Quincy, Mayor of that city, in an address before the People's Institute, in New York.

Mr. Quincy said he believed the provision of public baths was as much a municipal function as the provision of streets and sewers. Vast numbers of people in large cities must use municipal baths or none. Such institutions have a direct sanitary, social and moral value to the community.

The earliest considerable public bath in Europe was established at Liverpool in 1794. The first public bath in Boston dates back to 1866. The principal development of public baths throughout the world has occurred during the last quarter century. Our country is far behind Europe in this matter, but it seems ready to take it now, and since our American cities move so fast when they move at all, we may expect to see the extensive introduction of public baths in America during the next 5 to 10 years.

From 1866 to 1898 the public baths of Boston were managed by the Board of Health. In 1898 they were placed in charge of a special commission of seven members, two of whom are women, all serving without pay. The same commission has charge of the public comfort stations and the gymnasia. Regarding the appointment of this commission, the mayor remarked that to secure the best results in municipal work we must specialize in administration. The public baths were formerly only a small detail of the work of the Board of Health, but they now receive a large part of the time of seven persons who constitute the commission.

During the summer of 1898 the city maintained 23 different bathing establishments, or nearly one for each of the 25 wards of the city. Of these bathing places, 13 were floating baths, 6 were on the ocean beach, 2 on rivers and 2 artificial swimming pools.

The commission supplied suits for the bathers. These were free to all children of school age, and at one beach near the center of the city were free to all comers. At all other places such adults as did not bring their own suits were charged 5 cts. for suits furnished by the commission. A charge of 1 ct. (evidently to adults alone) is made for towels, which just about pays the laundry expenses for both towels and suits, the department owning and operating its own laundry.

The number of baths taken in 1898 was about 1,900,000, against 650,000 in 1897. The expense for administration in 1898 was under $38,000, or less than 2 cts. a bath. A large portion of the bathers are children, many of whom would have been barred out by a charge of even 1 ct. These facilities for children should be considered as a part of their education, physical being as essential as mental training.

Expert instruction in swimming was given in 1898, over 3,500 children learning to swim. Swimming should be a part of the curricula of our schools. Aside from its life-saving value, it is one of the best forms of exercise and recreation. The baths kept the children occupied much of the time through the summer vacation, which led Mr. Quincy to remark that it does not seem wise to expend millions upon the education of children during eight or nine months of the year and leave them to run wild the remainder of the time, as so many of those living in crowded cities must and do. Observations showed that the same children came to the baths day after day, making them a part of their summer life and recreation.

One of the largest swimming beaches was in charge of Mr. Peter McNally, who, besides being well fitted for the position, enjoys the reputation and possesses the attraction of having once swum across the English Channel.

In changing the subject from baths to gymnasia Mayor Quincy remarked, as pertinent to each subject, that one great failure of the American people is their not attaching sufficient importance to recreation. Industry of the head or the hands, not balanced by recreation, leads to a one-sided development.

A public gymnasium was given to the city of Boston two years ago, and is now under the care of the commission already named. Lately several classes of children have been under instruction numbering 800 in all, and some adults. This gymnasium is located in East Boston, which is cut off by water from other parts of the city. Such institutions become social centers, and foster democratic ideas.

In a few weeks a second gymnasium will be ready. This is being built from the public treasury at a cost of $20,000, and will, as far as Mayor Quincy knows, be the first municipal gymnasium in this country. It may cost $5,000 to $8,000 a year to run a large gymnasium in good shape, the mayor said, but he knew of no way in which more good could be done. Private effort can do much, but to be thoroughly sufficient and satisfactory a gymnasium for the people must be provided by

the city, and he knew of no better way of spending the public money. Education in the public schools, to be properly rounded on the physical side, must be accompanied by gymnastic work, which can be provided best in classes in public gymnasia.

The address was illustrated by numerous lantern slides, one of which showed a bathing establishment built entirely by the City Repair Department at a cost of $3,500. This department, the mayor stated, numbers in its force members of nearly all the building trades. Ordinarily it is not allowed to enter on new work, but it saves the city hundreds of dollars in repair work, directly, besides the indirect advantage incident to having an able and well-organized force ready for any emergency.

Another view showed some portable voting booths (which are used in Boston instead of corner groceries and saloons for registry and polling places). They were provided with temporary fittings, and were used during the summer as dressing places for bathers.

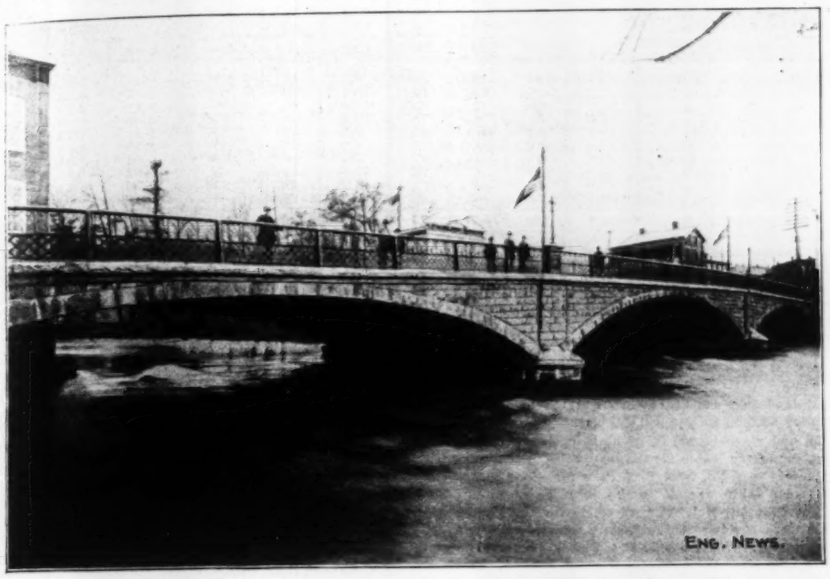


FIG. 1.—THREE-SPAN STONE FACED MELAN ARCH BRIDGE ACROSS THE PASSAIC RIVER, PATERSON, N. J.

Melan Arch Cons. Co., New York, Mr. Edwin Thacher, M. Am. Soc. C. E., Detroit, Mich., Designers.

THREE-SPAN MELAN ARCH BRIDGE ACROSS THE PASSAIC RIVER, PATERSON, N. J.

The accompanying illustrations show the handsome stone-faced Melan arch bridge recently built at Paterson, N. J., to carry West St. across the Passaic River. Measured on the center line of the bridge, the Passaic River, at Paterson, is 282.5 ft. wide between the retaining walls which bound it. These walls are at an angle to the direction of the river, and, as the face of the abutments are in line with the walls, the length of the bridge is 295 ft. in the clear on the upstream side, and 270 ft. on the downstream side.

The bridge consists of three arches of nearly equal length on the center line of the bridge, the center span being 89 ft. in the clear, and the two end spans about 88.25 ft. in the clear. The rise of each of the arches is 9.5 ft. The two piers are at right angles to the center line of bridge. With a width of 50 ft. 10 ins. on the soffit of the arches, the coping is carried out to give a total width of 54 ft., or 52 ft. in the clear between railings. At the ends of the bridge the roadway grade is at an elevation of 22 ft. above datum, rising by an easy grade to 25.5 ft. at the center.

The concrete of the arch rings is 15 ins. in thickness at the crown, gradually increasing to 66 ins. at the skewbacks, and embedding 10-in. I-beams weighing 25 lbs. per foot, spaced 3 ft. apart c. to c. Expansion joints are built in the spandrel walls over the piers to provide for thermal changes. The space between the spandrel walls is drained by 3-in. iron pipes built into the piers and abutments, and extending about 6 ins. beyond the face of the latter. The entire face of the spandrel walls and arches is finished with ashlar masonry of New Jersey brownstone, bonded into the concrete backing.

Satisfactory foundations were secured for both of the abutments and the north pier without driving piles, but for the south pier it was found necessary to use a pile foundation. The piers and abutments were faced with brownstone backed with concrete. The concrete for the arches was mixed 1 part of Portland cement, 2 parts sand and 4 parts broken stone, from ½-in. to 1 in. in size. The exposed soffits of the arches were faced with 1 in. of mortar, mixed 1 part Portland cement to 2 parts of sand, and placed at the same time as the balance of the concrete. In order to insure the monolithic character of the arches, the concreting was started from both skewbacks of a longitudinal section, and continued without interruption until the section was closed at the crown. The concrete was mixed in a machine, designed on the tumbling barrel principle, and containing a number of cast-iron balls, the effect of which was to reduce the mixture to a fine, homogeneous, and perfectly mixed concrete. The operation of this machine was very satisfactory and economical. The water was supplied from an elevated tank through the axle of the mixer, and was accurately measured to each batch by a gage on the tank.

The contract for this work was awarded on July 7, 1896, but the actual construction was delayed until June, 1897. The bridge was finished in the spring of 1898, since which time it has been under a heavy traffic, includng a double track electric railway, and has given entire satisfaction.

Ths is the longest Melan arch bridge in the United States, with the one exception of the Topeka bridge, illustrated in the Engineering News of April 2, 1896. The design for the Paterson bridge was made by the Melan Arch Construction Co. and Mr. Edwin Thacher, M. Am. Soc. C. E. The bridge is regarded as a good illustration of the adaptability of the solid concrete-steel arch to locations where the voussoir stone arch is not practical. The latter would hardly have been designed with a rise of less than 1-6 of the span, with the foundation available at this place; whereas the bridge as built has a rise of only 1-9.4 of the span. A voussoir stone arch at this location would have given either objectionable grades on the approaches, perhaps with considerable property damages, or would have obstructed the river channel with several more piers, to an extent prohibitory.

Fig. 1 is a view of the completed structure, and Fig. 2 is a half longitudinal section on the center line of the bridge. The work was constructed under the patents of the Melan Arch Construction Co., 35 Nassau St., New York city.

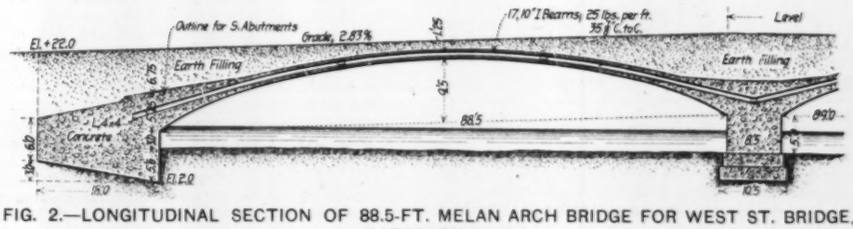


FIG. 2.—LONGITUDINAL SECTION OF 88.5-FT. MELAN ARCH BRIDGE FOR WEST ST. BRIDGE, PATERSON, N. J.

EXPLORATION OF SOIL BY WOOD-AUGERS.

In connection with a paper on a geologic and economic survey of the clay deposits of the lower Hudson Valley, lately presented to the American Institute of Mining Engineers, Mr. C. Catesby Jones, of Richmond, Va., describes his method of making borings in earth with ordinary wood-augers. As the method is simple, the plant easily procured and handled, and the results satisfactory in some soils, that part of his paper is here abstracted.

Ordinary wood-augers, varying in size from 1 to 2 ins. diameter of cutting face, were employed; these were welded to 18 ins. of black-iron pipe and connected by ordinary couplings with ½-in. or 1-in. pipe, in 6-ft. and 12-ft. sections, according to the diameter of auger used. Each drilling gang was supplied with a 20-ft. hoisting-gin, one 6-in. block and fall, 100 ft. of ¾-in. rope, one Yale & Towne ¼-ton differential chain-block, two augers, two handles, three pipe-wrenches, 12-ft. of 1¼-in. iron rod, 10½ ft. of 6 and 12-ft. pipe lengths, 20 to 50 ft. of 1¼ or 3-in. pipe for casing, one rock-drill, chains, etc. The portable hoisting-gin was arranged to fold together, and was used as a platform to carry the pipes, etc., lashed to it with rope. It could be easily carried by four men when thus loaded. Each gang included three men and a foreman.

The borings were regularly inspected as the ground was penetrated, and a record was kept of depths and all variations of material. The depth of the holes varied from a few feet to 100 ft. or more, and each gang averaged one hole per day out of the 150 holes sunk.

The gin was made of three pieces of 4 × 4-in. spruce timber, each 20 ft. long. The top of each piece was chamfered and a bolt inserted to prevent splitting—with the middle piece chamfered on two sides and the others on one side only. A ¾-in. bolt, with a square head and slot with pin or dowel, passes through the three sticks and from this is suspended the ¾-in. round iron "bail" with a "drop" sufficient to permit it to pass freely over the top of the middle leg; washers are used to protect the wood. Cleats nailed to the middle leg form a ladder by which the top may be reached.

The auger, with its 18 ins. of black pipe, is about 3 ft. long. The handle used in turning is 2 ft. long and is made of two pieces of ¾-in. round iron welded to a strong ring that will freely pass over the coupling of a 1-in. pipe; and in this ring is a strong ⅞-in. × 2½-in. set-screw, for securing the handle to the pipe. The chains used are made of ⅜-in. iron, short links, and are 3 ft. long, with a

heavy ring at one end and a hook at the other. The drill is made from 1¼-in. octagon steel and is 18 ins. long, with a 2-in. cutting face and a thread cut at one end for 1-in. couplings. The casing-pipe is in 4 or 5 ft. lengths, and used when sand or gravel become troublesome. The author says that he found it indispensable to provide a second outfit made of ½-in. pipe and fitted for a drill and auger with 1-in. cutting face. This is used when the larger borehole is obstructed in some way and further progress with that becomes impossible.

In commencing operations the auger is attached to a 12-ft. pipe section, the handle is adjusted and boring begins; great care being taken to start vertically. Five turns of the auger fills the bit and this is then drawn to the surface and examined. When the hole is deep enough to require the use of the hoisting-gin, the handle is loosened and dropped to the ground, after the prescribed turns are made, and the 3-ft. chain is passed around the pipe with the hook passed through the ring; the hook is then attached to the fall and the stress applied, dropping the chain for a new grip when the pipe is long. When the depth exceeds 30 ft., the pipe column must be disconnected, and to facilitate this operation a 3-ft. chain is looped and loosely dropped around the head of the gin and the pipe is directed so as to enter this loop, and it is thus held upright. The invariable rule, however, is to always have either the handle, or the chain under stress, attached to the pipe below a coupling while the auger remains in the hole. With a little practice 100 ft. of pipe can be started, pulled up, disconnected, the auger cleaned and the whole pipe let down into the hole again in a few minutes.

When sand is encountered, enough water must be poured into the hole to stick the grains together and the auger will then lift it. Fine running gravel will frequently make a hole impossible, and quicksand is another obstacle to deep boring, and casing will not overcome this difficulty unless it is a thin stratum. A section of pipe, becoming disconnected in the hole, may be recovered by using a clean, freshly-oiled coupling; and a loose coupling may often be caught by driving a tapered stick into the end of a pipe. An auger broken at the shank may be grappled for by a noose of short-link chain lowered by two strings and then fished up with a hook on the end of the ½-in. pipe. An important rule is to avoid gorging the auger at great depths; and it is not advisable in such cases to reverse the auger to release it.

THE STEEL RAILS EXPORTED BY THE UNITED States in 1898, says the "Iron Trade Review," amounted to 291,038 tons. Europe took 31,916 tons; British North America, 107,669 tons; Central America and British Honduras, 1,870 tons; Mexico, 37,781 tons; West Indies and Bermuda, 7,338 tons; South America, 14,833 tons; Japan, 45,131 tons; Asia and Oceanica, 27,880 tons; Africa, 17,420 tons. In 1897 the total rail export was 142,808 tons. London "Engineering" puts the total rail exports for England, for 1898, at 476,786 tons, as compared with 579,983 tons in 1897, and 581,249 tons in 1896. The declines in export noted correspond closely with the points receiving the largest amounts from the United States, and the falling off is frankly said to be attributable to American competition.

A TRIAL OF MOTOR VEHICLES FOR HEAVY TRAFFIC is to be held next August under the auspices of the Liverpool Self-propelling Traffic Association, Mr. E. Shrapnell Smith, Hon. Secretary, Liverpool, England. The object of the trial is to encourage the development of types of heavy motor wagons suitable for trade or agricultural requirements, and capable of economically taking the place of horses and of competing with existing railway rates in the transport of heavy goods over distances up to 40 miles. Full regulations have been published for four classes of vehicles, in which the minimum load ranges from 2 to 6½ tons; the maximum dead weight from 2 to 4 tons, and the minimum level platform area from 50 to 110 sq. ft. The points considered will be the cost or economy of working, control, working conditions, construction, and steam, oil and electrically propelled vehicles. All vehicles to compete must be ready for inspection by the judges by July 28, 1899.

LARGE ELECTRIC CABLE CONTRACTS were recently let by the Third Avenue Ry. Co., of New York city, in connection with the work of changing its street railway line from the cable to the conduit electric system. It is understood that the contracts amounted to $400,000, and included 300,000 ft. of 1,000,000 circular mils paper-feeder cable, and about 80,000 ft. of high-tension rubber-covered three-conductor cable for 11,000 volts, each conductor equivalent to a No. 0000 B. & S. wire. The contract for the feeder cable was let to the John A. Roebling's Sons Co., of Trenton, N.J. The contracts for the high-tension cable were divided as follows: General Electric Co., Schenectady, N. Y., 40,000 ft.; Safety Insulated Wire & Cable Co., New York, 20,000 ft., and John A. Roebling's Sons Co., 20,000 ft. It is stated that the total amount to be spent for cables will be between $2,000,000 and $3,000,000.

WEATHER TABLE FOR FEBRUARY, 1899. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—Rain or melted snow. (Inches.) Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	15.5	48	—25	73	9 3	44	N	1.69	0.66	9
	Portland, Me.	22.3	51	—6	57	7.9	48	N	3.41	1.80	10
	New York City	26.9	50	—6	56	16 6	64	S	5 46	1.05	15
	Pittsburg, Pa.	25.5	60	—20	80	7 3	30	NW	2.68	0.54	16
	Chicago, Ill.	17.9	49	—21	70	18 1	48	SE	1.60	0.98	8
	Omaha, Neb.	14.7	62	—26	88	8.3	28	SE	0.71	0.60	6
	St. Paul, Minn.	7.6	50	—33	83	8.7	29	NW	0.95	0.55	10
	Duluth, Minn.	6.3	50	—36	86	10.7	36	NW	0.66	0.57	3
	Bismarck, N. Dak.	1.7	52	—37	89	11.1	36	NW	0.18	0.08	6
	Average.	15.4	52	—23	76	10.9	40	—	1.93	0.76	9
Southern Cities.	Washington, D. C.	27.4	59	—15	74	8.2	48	NW	6.17	1.57	18
	Louisville, Ky.	27.2	65	—14	79	10.1	38	SW	1.84	0.53	13
	St. Louis, Mo.	24.1	66	—16	82	11.6	41	W	3.40	2.46	8
	Savannah, Ga.	51.0	81	8	73	10.2	36	NW	6.66	2.15	14
	Kansas City, Mo.	19 4	63	—22	85	9.5	32	NW	1.54	1.19	9
	Jacksonville, Fla.	55.4	81	10	71	8.8	40	SW	3.38	1.54	13
	Chattanooga, Tenn.	35.6	67	—10	77	9.2	40	NW	6.81	1.84	16
	New Orleans, La.	49.4	79	7	72	11.6	41	N	2.93	0.85	11
	Memphis, Tenn.	32.0	66	—9	75	11.7	48	NW	4.33	1.41	13
	Palestine, Tex.	39.7	74	—6	80	8 5	36	S	3.46	2.52	13
	Average.	36.1	70	—7	77	9.9	40	—	4.05	1.61	13
Western Cities.	Helena, Mont.	9.8	51	—30	81	8.8	44	SW	0.53	0.38	6
	Port Crescent, Wash.	36.8	51	10	41	8.3	38	SE	5.12	1.00	22
	San Francisco, Cal.	51.6	80	34	46	8.7	39	W	0.10	0.08	2
	Salt Lake City, Utah.	29.6	51	—10	61	5.0	30	NW	2.98	0.81	14
	Santa Fe, N. Mex.	28.2	53	—5	58	7.5	36	SW	0.73	0.26	8
	Denver, Colo.	17.6	56	—22	78	8.9	42	NW	0.58	0.27	9
	Yuma, Ariz.	—	—	—	—	—	—	—	—	—	—
	Average.	28.9	57	—4	61	7.4	38	—	1.67	0.47	10

A JAPANESE GOVERNMENT IRON FOUNDRY, says U. S. Consul-General Gowey, is to be established in Fukuoka district, at a total estimated cost of 9,601,000 yen. No details are given as to equipment or proposed use.

MUNICIPAL OWNERSHIP OF THE WATER-WORKS of Delaware, O., is proposed. A report on the condition and value of the plant owned by the Delaware Water Co. has been made by Mr. John W. Hill, M. Am. Soc. C. E., of Cincinnati. The cost of duplicating the tangible property of the company is estimated at $125,841 and the deterioration, in some eight or nine years, at $12,204. Of several methods of determining a fair price to be paid for the works, Mr. Hill chooses one based upon the demonstrated ability of the plant to pay interest and sinking fund charges, and provide a fund for its renewal at the end of a term of years, representing the probable usefulness of the plant. The net revenue of the plant for 1898 was $12,424. Of this $1,291 per year, at 2½% compound interest, would be required for the proposed renewal fund, leaving $11,133 available for fixed charges on the value of the property. The present value therefore becomes, he estimates, $153,702, from which must be deducted $12,204 on account of estimated deterioration, leaving $141,498 as what the city can afford to pay for the plant, considering the actual net revenue for 1898.

A COMPLETE CHEMICAL AND BACTERIOLOGICAL laboratory has been equipped by the Spring Brook Water Supply Co., which controls the water-works of Wilkes-Barre, Pa., and many other towns located between that city and Scranton. Prof. W. H. Dean has been placed in charge of the laboratory, which is located at Wilkes-Barre. We are indebted to Mr. L. A. Watres, of Scranton, President of the company, for the above information.

THE TYPHOID RECORD IN PHILADELPHIA last week was 419 new cases and 39 deaths, making 3,649 cases and 380 deaths thus far this year. "That is rather more," the Philadelphia "Ledger" states, "than two deaths for each of the 176 councilmen." On Wednesday the high-water mark for one day, 71 new cases, was reached, notwithstanding which the Select Council on the following day voted against the water filtration loan. Since the above was written the record has been exceeded, there having been 74 cases and 12 deaths reported Tuesday.

AN INTERNATIONAL EXHIBITION of motor-vehicles will be held at Berlin, Germany, in May, 1899, according to "Le Moniteur Officiel du Commerce," of Paris. This exhibition will admit motor-vehicles of all sorts and also all manner of motor-vehicle accessories.

DAMAGES FOR WATER RIGHTS to the amount of $508,395 have been awarded against the city of Worcester, Mass., and in favor of mill owners, on account of the taking by the city of the waters of Kettle Brook for its water supply. The commissioners state that in making the awards they sought to ascertain the condition of the propery in 1895, at the time of the taking, including the amount of water power that had been or might be developed. The amount of horse power lost, and its value in relation to each property, was taken as the most important element, but all other factors were also considered, such as "the relative value of the power taken to the whole estate, the location, capacity, adaptability, conditions, the water in the reservoir at the time of the taking." The awards include interest from June 21, 1895. The commissioners were Messrs. E. C. Bumpus, Tremont Building, Boston, to whom we are indebted for a copy of the award, Wm. Whiting and Geo. E. Evans.

THE BOSTON SOCIETY OF MUNICIPAL OFFICIALS is the latest innovation in municipal affairs. About 40 of a membership of 90 met at Young's Hotel, it is said, for the first monthly dinner on March 8. It is proposed to have a special subject and one or more speakers for each meeting. The object is to promote acquaintance among the officials of the city, quicken public interest in local affairs and obtain broader information regarding specific municipal questions. Among those present at the last meeting were: Messrs. Josiah Quincy, Mayor; Wm. Jackson, M. Am. Soc. C. E., City Engineer; Benj. W. Wells, Superintendent of Streets; John R. Murphy, Water Commissioner; and several ladies, members of various commissions.

ARCHITECTURAL EDUCATION in the United States was reported upon by a committee at the last annual convention of the American Institute of Architects. The first architectural school in the United States was established in 1869 at the Massachusetts Institute of Technology, by Prof. W. R. Ware. Since that time flourishing schools have been established at Cornell, the University of Illinois, Columbia, Pratt Institute, Syracuse, University of Pennsylvania, University of Chicago, Harvard, Tulane, and McGill. Since their establishment about 3,250 students have been enrolled in these schools, and about 650 have graduated, of whom 120 are reported to be now in practise. The committee favored the establishment of an educational requirement for admission to the Institute, and suggested that the diploma of a graduate of a recognized school might be accepted in lieu of an examination.

TO DETERMINE POLAR CURRENTS the Geographical Society of Philadelphia, acting with the government, has had 50 patent casks made in San Francisco, and these will be sent out on the U. S. revenue cutter "Bear" and ships of the Pacific whaling fleet, to be distributed in different parts of the ocean. These are to be picked up later by vessels meeting them, and the Society hopes in this way to determine the currents of the Arctic Ocean and to test the theory of an open passage around the pole between the Pacific and Atlantic Oceans.